REPORT RESUMES

ED 002 923 24

EVALUATION AND FOLLOWUP STUDY OF A SUMMER SCIENCE AND MATHEMATICS PROGRAM FOR TALENTED SECONDARY SCHOOL STUDENTS.

BY- COOLEY, WILLIAM W. BASSETT, ROBERT D.
HARVARD UNIV., CAMBRIDGE, MASS.,GRAD. SCH.OF EDUC.

REPORT NUMBER CRP-715 PUB DATE 30 JUN 60
EDRS PRICE MF-$0.18 HC-$4.68 117P.

DESCRIPTORS- *SECONDARY SCHOOL STUDENTS, *SUMMER PROGRAMS, *SCIENCE COURSES, *MATHEMATICS CURRICULUM, *TALENTED STUDENTS, EDUCATIONAL IMPROVEMENT, RESEARCH SKILLS, SCIENCE CAREERS, CAMBRIDGE, MASS.

THIS STUDY WAS TO EVALUATE A SUMMER PROGRAM IN SCIENCE AND MATHEMATICS FOR 60 PROMISING SCIENCE STUDENTS, AND TO DETERMINE THE EFFECTS OF SUCH A PROGRAM ON THE BEHAVIOR OF STUDENTS IN CLASSES DURING THE ENSUING YEAR AND ON THEIR FUTURE CAREER DECISIONS. THE FIRST 2 OF THE 10 WEEKS OF THIS PROGRAM THE STUDENTS WERE GIVEN ADVANCED INSTRUCTION BY VISITING SCIENTISTS AND THAYER ACADEMY PERSONNEL. THE MORNING CONSISTED OF CLASSROOM INSTRUCTION AND THE AFTERNOON WAS DEVOTED TO LABORATORY AND LIBRARY RESEARCH. EACH EVENING A VISITING SCIENTIST PRESENTED A REPORT OF RESEARCH ON A DIFFERENT FRONTIER OF SCIENCE. FOR CLASSES AND LABORATORY, THE GROUP WAS DIVIDED INTO FOUR SECTIONS, EACH ONE EMPHASIZING EITHER BIOLOGY, CHEMISTRY, PHYSICS, OR MATHEMATICS. THE SECTIONS WERE ASSIGNED ACCORDING TO THE STUDENT'S MAJOR INTERESTS. THE LAST 8 WEEKS OF THE PROGRAM WERE SPENT IN SEPARATE UNIVERSITY AND INDUSTRIAL LABORATORIES WHERE STUDENTS WORKED UNDER THE DIRECT GUIDANCE OF A RESEARCH SCIENTIST AND UNDER PERIODIC SUPERVISION OF THAYER PERSONNEL. THE MAJOR CHANGES OBSERVED DURING THE 10-WEEK PERIOD INVOLVED THE STUDENT'S IMAGE OF SCIENCE AND SCIENTISTS, AND STUDENT PLANS FOR COLLEGE AND CAREER. THESE ARE HIGHLY INTERRELATED AND ARE EXPECTED RESULTS OF A PROGRAM IN WHICH STUDENT EXPOSURE TO SCIENTISTS IN ACTION IS THE PRIMARY ACTIVITY. AS A CAREER GUIDANCE DEVICE, THE PROGRAM WAS HIGHLY SUCCESSFUL. FUTURE INVESTIGATIONS SHOULD BE CONCERNED WITH THE RELATIVE MERITS OF VARIOUS APPROACHES TO THE SUMMER PROGRAM DESIGN. (JL)

ED002523

U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
Office of Education
This document has been reproduced exactly as received from the person or organization originating it. Points of view or opinions stated do not necessarily represent official Office of Education position or policy.

Evaluation and Follow-up Study of a Summer Science and Mathematics Program for Talented Secondary School Students

William W. Cooley

and

Robert D. Bassett

Graduate School of Education
Harvard University
Cambridge, Mass.
June 30, 1960

The research reported herein was performed pursuant to a contract with the United States Office of Education, Department of Health, Education, and Welfare. Cooperative Research Project No. 715.

3414a

Preface

Summer science and mathematics institutes for talented high school students have increased rapidly in number during recent years. In an attempt to inquire into the consequences of such programs, an independent study was undertaken at the Harvard Graduate School of Education to evaluate and follow-up one of these summer institutes. The particular program selected for study was conducted at Thayer Academy in Braintree, Massachusetts during the summer of 1959. Here fifty-five high school juniors, primarily from eastern Massachusetts, spent two weeks studying at the Academy and eight weeks working alongside research scientists in neighboring university and industrial laboratories.

We do not pretend that this particular program is representative of all such summer programs. However, we do feel that many of our results will be of interest to educators who are concerned about this type of procedure for enriching the educational experience of talented high school students. If nothing else, we hope that this effort may encourage further evaluations of this new and important educational innovation.

We would like to extend our thanks to the fifty-five students who so patiently served as testees, respondents, and interviewees in this undertaking; to Dr. Gordon Thayer, Mr. William Stergios, and the staff at Thayer Academy for their splendid cooperation; and to Mrs. Elaine Purpel and Mrs. Elinor Najita who performed clerical and secretarial services for this project.

We would also like to acknowledge the assistance of Professor Fletcher Watson who served as consultant and Mr. Eugene Lee who assisted in the data analysis.

Cambridge, Mass.
June 30, 1960

William W. Cooley, Principal Investigator
Robert D. Bassett, Research Assistant

TABLE OF CONTENTS

Preface

List of Tables

Chapter I: SUMMER SCIENCE PROGRAMS FOR TALENTED STUDENTS . . . 1

- Purpose of This Investigation
- Program of Summer Studies at Thayer Academy
- Related Research

Chapter II: OBSERVATIONAL PROCEDURES 8

- The Summer Session
- Follow-up Observations
- Other Data

Chapter III: ANALYSIS OF THE SUMMER OBSERVATIONS 15

- Description of the Students
- Student Changes
- Personality and Environmental Factors
- Student "Success" in the Program
- Personal Observations

Chapter IV: ANALYSIS OF FOLLOW-UP OBSERVATIONS 50

- The Students
- The Teachers
- The Parents

Chapter V: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS 69

- The Ten-Week Program
- Back to School Follow-up
- Comparisons with Peer Groups
- Further Research

Bibliography 78

TABLE OF CONTENTS - cont'd.

Appendix

Summer Program Descriptions

Program Staff and Participating Laboratories i

Courses of Study: Two Week Institute ii

Evening Lecture Series v

Student Research Topics vi

Financial Report of Program viii

Summer and Follow-up Instruments

1958 Follow-up Questionnaire, June 1959 ix

General Questionnaire , June 1959 xiii

Student Reactions to Program, August 1959 xix

Your Present Career Plans, August 1959 xxi

Rating Directions for Supervisors, Fall 1959 . . . xxii

Student Follow-up Questionnaire, Spring 1960 . . . xxiii

Letter to Principal Arranging for Interviews . . . xxvi

Student Follow-up Interview, Spring 1960 xxvii

Teacher Follow-up Interview, Spring 1960 xxix

Follow-up Questionnaire II, June 1960 xxx

Letter accompanying Parent Questionnaire xxxi

Parent Questionnaire, May 1960 xxxii

LIST OF TABLES

Table	Description	Page
I	Distribution of Schools and Students	4
II	Descriptive Statistics of Candidates and Participants . . .	16
III	Science and Mathematics Ability and Interest	17
IV	Tests of the Significance of Pupil Gain	19
V	Changes in FAS Item Responses	21
VI	Career Goal Changes	28
VII	Correlations of K-GZ Scales With Discriminant Score	32
VIII	Father's Education	37
IX	Mother's Education	38
X	Numbers of Peers Planning College	38
XI	College Plans of Best Friends	38
XII	Number of Older Siblings	39
XIII	Family Religion	39
XIV	Membership in School Clubs	39
XV	Officer in School Clubs	40
XVI	School or City Athletics	40
XVII	Multiple Correlations With Rated Success Criterion	42
XVIII	Course and Grade Distributions	51
XIX	Number of Courses Taken by Students	52
XX	Student Reaction to Science and Mathematics Courses	54
XXI	Students in Non-Class Science Activities	55
XXII	Sharing of Student Summer Experience	56
XXIII	Student Recommendations for Improving Program	57
XXIV	Attributes Important for Program Participation	58
XXV	Special Provisions for Students	61
XXVI	Program Benefits Reported by Parents	67
XXVII	Evidence of Change Reported by Parents	67
XXVIII	Parent Recommendations	68

Chapter I

SUMMER SCIENCE PROGRAMS FOR TALENTED STUDENTS

National efforts to improve science education in recent years have increased on a very broad scale. Special training programs for science teachers, development of modern science curricula and teaching materials, aid for purchasing science equipment, support of graduate students in science, and science education research are some of the areas in which the federal government has given financial support. However, none of these efforts were specially devised to provide directly for gifted high school students.

The first direct attempt of the federal government to enrich the educational experiences of talented high school students was made in the summer of 1958, when a few special programs in science and mathematics received financial support. Privately financed programs had been conducted in previous summers, but these included only a few students. The first large scale try-out came in 1959, when the National Science Foundation supported 117 summer programs throughout the country. During the summer of 1960, 137 institutions will provide for about 7,000 students. These programs vary widely in detail of operations, but in general the programs are one of two types: (1) formal advanced course work in science and mathematics with some supplemental laboratory work, or (2) research experience in university and industrial laboratories.

The nation-wide student interest in such summer study is highly encouraging. Evidence for this is that the ratio of applicants to accepted participants has been ten to one.[1] Certainly this educational innovation, growing so rapidly in size and interest, needs to be carefully examined from many directions.

---

[1] Richardson, Bellows, Henry and Co, Inc. "A Look at the 1959 National Science Foundation's 'Summer Science Training Program for High-Ability Secondary School Students'". Report prepared for NSF. December 31, 1959.

General purpose of the programs: The general intent of these programs can best be described by quoting two statements of the National Science Foundation. "The training offered by this program is designed to provide the superior high school student with educational experiences in science and mathematics beyond that normally available in high school courses."[1] The primary aim of the programs is to "encourage the scientific interests of high ability secondary school students by providing them with opportunities to participate in study and research programs set up especially for them".[2]

Purpose of This Investigation

Because these special summer institutes were increasing in number so rapidly and their promise seemed so great, we decided that a pilot investigation which considered one program in detail would be a worthwhile enterprise. Therefore, a research study was designed which had the following major objectives: (1) to determine to what extent a particular institute accomplished its stated purposes; (2) to examine the "back to school" consequences of that program; (3) to develop procedures and identify evaluative instruments which could be used in comparing the relative merits of similar programs in subsequent summers; (4) to use the program participants as a comparison group for 200 students of the same age and geographic region who are subjects in a study of the career development of scientists.[3]

---

[1] Announcement of Summer Science Training Program for High-Ability Secondary School Students. NSF. 1959.

[2] National Science Foundation programs for education in the sciences. NSF Pub. No. 59-6. NSF, Washington 25, D.C.

[3] "Career Development of Scientists: An Overlapping Longitudinal Study". U.S. Office of Education Cooperative Research Project No. 436. W.W. Cooley, Principal Investigator. Harvard University. Sept. 1959. Mimeographed.

Because this Scientific Careers Study (SCS) will be mentioned at several points in this report, a brief description is desirable.

The SCS began in the fall of 1958 when 700 boys from five age groups (grades 5, 8, 11, and college sophomores and seniors) were selected and tested for a five year follow-up study. It was designed so that each group would, during the next five years, pass through a critical period in career development where certain decisions had to be made regarding school and future work. Through continuous contact over the five year period we hope to identify the significant factors which affect movement through the schools and into careers. We are focusing particularly upon students heading toward careers in science and technology.

The summer program (held at Thayer Academy) with which this investigation is concerned, was drawing students from the same age group and geographic region as the 200 students in the grade 11 group of the SCS. This seemed an ideal opportunity for comparison purposes.

Program of Summer Studies at Thayer Academy

During the summer of 1959, Thayer Academy in Braintree, Massachusetts, conducted its second summer advance study program in science and mathematics for talented secondary students. This program was supported by grants from the Fund for the Advancement of Education of the Ford Foundation, and from the National Science Foundation. The American Academy of Arts and Sciences served as the sponsoring agency. The major purposes of this program were three-fold: (1) to increase the student's general competence in science and mathematics; (2) to familiarize students with the problems of initiating, planning, and conducting research; (3) to promote a better understanding of the roles of scientists and engineers.

The program was designed so as not to duplicate work which would be available to students in their local schools during the school year, but rather to emphasize unique and challenging educational experiences which are not customarily available to secondary school students.

Participants: Fifty-five academically talented students who had completed their junior year in high school were chosen from approximately 250 applicants. The nine girls and forty-six boys came from thirty-seven different public, private, and parochial schools in the greater Boston area. Table I present the distribution of schools and students.

Table I

Distribution of Schools and Students

Type of School	Number of Schools	Number of Students
Public	33	47
Private	3	7
Parochial	1	1
Totals	37	55

Selection of Students: The screening of the 250 applicants was conducted in the spring by the same Thayer Academy staff associated with the summer program. Applications had been limited to students who were enrolled as juniors in high school. Applicants were required to have completed three years of college preparatory mathematics and one college preparatory science laboratory course (two were preferred). Publicity had been provided through circulars sent to neighboring schools, by newspapers, and by personal contact of former participants. As classroom teachers were urged to encourage only two or three of their best potential candidates to apply for this program, certain local selection factors often operated even before application was made.

The initial screening made use of school transcripts, teacher recommendations, and personal data describing the student's interests and previous activities in science and math. In addition, each applicant attended Thayer Academy one Saturday in the spring to take a battery of ability and aptitude tests. (See Chapter II for a description of these tests.) Using these data, and placing major emphasis on test scores, approximately 100 students were selected to be interviewed personally. The final selection of students and their alternates were determined primarily from considerations concerning the potential working relationship of the student with a cooperating scientist.

The Program: The first two of the ten weeks of this program were held at Thayer Academy where the students were given advanced instruction by visiting scientists and Thayer personnel. Morning periods consisted of classroom instruction and the afternoon was devoted to laboratory and library research. Each evening a visiting scientist presented a report of research on a different frontier of science. For classes and laboratory, the group was divided into four sections, each one emphasizing either biology, chemistry, physics, or mathematics. In so far as possible, the sections were assigned according to the student's major interests. One of the Thayer staff served as supervisor and advisor for each of the four sections.

The last eight weeks of the program were spent in separate university and industrial laboratories where students worked under the direct guidance of a research scientist, and under the periodic supervision of Thayer personnel. The student prepared a report on one phase of this work, and subsequently presented a seminar report to the rest of the group at the last day's symposium. The student's two-week section generally determined the area of science in which he did his eight-week laboratory research.

During the eight-week period, the students returned each Wednesday night to Thayer Academy for dinner, followed by group discussions and further lectures by visiting scientists.

Details of the course of study, lecture series, student research topics, etc. are found in the Appendix, pages i to viii.

Personal Accomodations: Although no attempt was made to house all students for the summer, provisions were made for a few students to stay in private homes near the Academy during the first two weeks. Also, certain travel reimbursements were provided from the foundation funds supporting this program.

Related Research

At the present time wide variation is found in the nature and extent of summer study programs in science and mathematics for talented secondary school students. However, few detailed evaluation studies are reported to have been conducted in these programs. Most periodical articles reporting on summer study are primarily of a descriptive nature. References for the published descriptions and the few efforts at objective evaluations are listed in the bibliography following Chapter V. There are two major evaluative efforts which deserve comment, however.

During the summer of 1959 the National Science Foundation requested two outside consulting organizations to make independent evaluations of the NSF supported programs. These studies were carried out by Science

Research Associates of Chicago[1] and by Richardson, Bellows, Henry & Co. Inc. of New York.[2]

Data for these studies were gathered from student questionnaires and from observations made by consultants who interviewed both students and instructors at selected programs. They found that selection procedures had resulted in the majority of students coming from homes of relatively high social and economic backgrounds, consequently the need to re-evaluate these screening techniques was suggested. Additional recommendations and implications for science education may be found at length in the reports of each of these studies. In general, each concluded that the basic objectives of the programs were being substantially fulfilled, and that the programs have been of major importance to the individual student participant. Further study was recommended to determine what benefits such programs might be having for the local high schools and communities to which the students returned. Further evaluation will be conducted during the summer of 1960 for the National Science Foundation with particular emphasis upon gathering objective data both during the summer and the subsequent school year.

In view of the sparsity of research into the consequences of this educational innovation, the research reported herein should help fill a gap now existing in the literature. Although two large scale inquiries have gathered student and expert opinion on the worthiness and consequences of the various programs, this seems to be the first attempt to make a detailed evalution of both student change and "after treatment" effects of a single institute.

---

[1] Science Research Associates. "Evalution of the 1959 NSF Summer Science Training Program for Secondary School Students: Report No. 2 Contract NSF - C115". Submitted to NSF, Washington, D.C. February,1960.

[2] Richardson, Bellows, Henry & Co. Inc. op. cit.

Chapter II

OBSERVATIONAL PROCEDURES

After the objectives of this research project were formulated, as outlined at the beginning of Chapter I, the various data collecting procedures and instruments were chosen. For purposes of description, these operations can be classified into two general phases: (A) testing and interviewing during the ten-week summer session, primarily to determine the immediate effects of the program and also to secure information on potential "future scientists"; (B) follow-up questionnaires and interviews during the following school year to study the long-term summer's effects. Before considering the results of our data analysis, an outline of the collection operations and the instruments used will be helpful to the reader.

The Summer Session

Student change: One of the major goals of this research project was to determine whether or not available evaluative instruments are sufficiently sensitive to detect bahavioral changes in the students during the ten-week program. Previous experimentation in science education was not a sufficient basis for making such decisions because mastery of facts and principles has tended to be the sole criterion used, and other (and more elusive)criteria must be considered. The instruments finally selected were administered at the beginning and at the end of the ten-week institute.

To measure changes in student perceptions of science and scientists the new Facts About Science Test was used. This FAS (still in experimental form) consists of 80 multiple choice items concerning the scientific enterprise, the methods and aims of science, and characteristics of scientists.

To assess student gain in such abilities as screening hypotheses, interpreting data, quantitative reasoning, etc. the STEP Science Test was used. Because of the high ability of this group, the college form of this test was selected.

The STEP Mathematics test was used to assess student gain in mathematical literacy. Again, the college form was used. The emphasis in this test is on number and operation, symbolism, measurement and geometry, function and relation, inferential reasoning, probability and statistics.

No instrument could be found which would detect possible student changes in their college and long range career plans, or their perceptions of themselves in relation to possible scientific careers. For this reason we developed our own questionnaires on the basis of experience resulting from the Scientific Careers Study.[1] These questionnaires can be found in the appendix of this report.

To summarize the various attempts at measuring student changes, the pre- and post-test batteries are listed below.

Pre-test Battery:

The following instruments were administered during the first two days of the 1959 summer program:

1. STEP Science, Form 1A (Sequential Test of Educational Progress published by Educational Testing Service, Princeton, N.J.)
2. STEP Math, Form 1A (Educational Testing Service)
3. Facts About Science (Educational Testing Service, still in experimental form)
4. Career Plans Questionnaire (Prepared by this research project.)

---

[1] See Chapter I for a brief description of the Scientific Careers Study.

Post-test Battery:

The following tests were administered during the next to the last day of the ten-week program:

1. STEP Science, Form 1B (to assess student gain in such abilities as screening hypotheses, interpreting data, quantitative reasoning, etc.)
2. STEP Mathematics, Form 1B (to assess student gain in mathematical literacy.)
3. Facts About Science Test. (to assess student change in perceptions of science and scientists.)
4. Post-questionnaire (covering effects which summer program may have had on college career plans.

All testing was conducted by our research staff and neither pre- nor post-tests were examined by personnel at Thayer Academy. This is important in considering student gains. Under these conditions, instructional materials could not have been designed specifically for purposes of improving test performance. The instruments were chosen by the investigators after consideration of the purposes of the Thayer Academy summer program. They appeared to have face validity for evaluating those purposes.

Environmental and Personality Attributes: In an effort to provide additional information about high school students who are contemplating careers in science, we included in the pre-test battery a number of instruments which had been administered to about 200 students of the same age group as part of the Scientific Careers Study. This made possible several interesting comparisons. As can be seen in the following list, temperament, interests, and general background information were the areas inventoried in this phase of the research work.[1]

---

[1] A group administered version of the Thematic Apperception Test was also included in this battery for the purpose of measuring aspects of student motivation. Unfortunately, scoring problems arose which have not yet been solved. This problem will be considered in a future report on the SCS.

1. Guilford-Zimmerman Temperament Survey (Published by the Sheridan Supply Co., Beverly Hills, Calif.)
2. Kuder Preference Record - Vocational, Form CM (published by Science Research Associates, Chicago, Ill.)
3. General questionnaire (family data, school and personal background See appendix)

Observations of the "Treatment": It is certainly naive to expect that catalogue descriptions of courses or special summer programs are sufficient and reliable for the purposes of describing treatments in educational research. For this reason, one of the investigators (Bassett) spent much of the ten-week program attending classes, talking informally with students and teachers, and together with the Thayer supervisors, visiting the students while they were working in university and industrial laboratories, interviewing both the students and the cooperating scientists.

This was indeed a time-consuming task, but its value lies in the fact that these were observations made by someone who was not involved in nor responsible for the details of the program. These observations are summarized in Chapter III of this report.

Follow-up Observations

Data for this phase of the study were gathered by a series of questionnaires and personal interviews in the spring of the following school year. The people contacted included the fifty-five summer participants, their high school science or mathematics teacher, and their parents.

As a pilot study for this phase of our operations, a questionnaire was sent in the spring of 1959 to those students who had participated in the first summer's program held at Thayer Academy in 1958. The questionnaire covered school activities and the effects of the summer program on subsequent education and on career plans as estimated by the students themselves. (Copies of all questionnaires and interview schedules devised for this research project are included in the Appendix.)

The replies to that questionnaire tended to confirm our reluctance to rely solely upon this type of measuring instrument for purposes of follow-up evaluation. As suspected, the nature and type of responses are not only limited by such a device, but also many students seemed to try to give the "right answer" to questions. When students were asked, for example, whether the summer's experience had changed their ideas about what scientists were like as people, several of the responses appeared nicely manufactured. Thus, the personal interview seemed necessary for probing deeper than is possible with the questionnaire.

The attempt to gather follow-up data in the spring of 1960 was facilitated by the fact that the students had met the members of the research team during the previous summer and were familiar with the nature and purpose of this study. A preliminary questionnaire was sent to the students in March in order to obtain descriptive data about their school activities, course schedules, etc. A 100% return of these questionnaires provided considerable data to which the interviewer could subsequently refer and facilitated greatly the scheduling of the interviews.

During the month of April, arrangements were made with each school to conduct separate, personal interviews with each teacher and student for a minimum of twenty minutes. Where the student had specialized in a science area during the summer, the interview was made with the student's present science teacher, whether or not the teacher was familiar with the program. For those who had specialized in mathematics, the present math teacher was interviewed. In cases where two or more students came from the same school, it often occurred that both the student's science and math teacher were contacted and it was thus possible to get two independent statements of the student's behavior in different classes and some indication as to possible transfer of benefits from one specialized field to another. In only four instances was it impossible to interview the science or math teachers. For two students who were taking no science, arrangements were made to interview other teachers who were familiar with the student's program. No attempt was made to interview the teachers of the two students who had been accepted for Early Admission into two local colleges. Later reference will be made to these exceptions. Separate telephone interviews were held with the one student and his teacher who had come from New York to participate in this program. All the interviewing was done by the same investigator who had also interviewed the students and their cooperating scientists during the summer.

In addition to the student questionnaires and the student and teacher interviews, the spring follow-up included a short questionnaire to the parents of the participants. The questions were highly exploratory and merely attempted to obtain the parents' perceptions of the primary benefits of such programs, their disadvantages, and suggestions for improvements. A 91% return was obtained from these questionnaires.

Other Data

The Thayer Academy staff was kind enough to make available to us the data which they collected in screening candidates and in their student appraisal operations. This information is outlined below.

1. Tests administered for initial screening purposes:
   1. Otis Self-Administration Tests of Mental Ability: Higher Examination: Form C.
   2. American Council on Education Psychological Examination, 1948 Edition.
   3. Cooperative Test on Secondary School Mathematics: Higher Level, Form S (Educational Testing Service).
2. Student appraisals of two-week Thayer program.
3. Student appraisals of eight-week laboratory research.
4. Cooperating scientist appraisal of student.
5. Student theses (research reports of their eight-week laboratory work).

Chapter III

ANALYSIS OF THE SUMMER OBSERVATIONS

One difficulty with most of the available special program evaluations in education is their static nature. Page after page of percentages, percentiles, and medians are presented in an effort to describe the participants, their test scores, background, and their responses to questions like: "Was the program worthwhile?" Our research efforts have been primarily directed toward the problem of measuring pupil change during this summer program, the impact of that experience upon the student during the following school year, and the differences and similarities between the Thayer participants and 200 other students of the same age group and geographic location. We hope that this approach will be more informative.

However, some descriptive statistics will probably be useful for obtaining a general picture of ability and interest tendencies of this very able group of students. Before proceeding, then, a few selected indices will be presented.

Description of the Students

Screening Data: As part of their selection process, the Thayer staff administered a number of tests of academic aptitude. They have published some of these data in their 1959 Report[1]. Table II summarizes those findings. It not only gives the general ability level of the fifty-five participants, but also the general ability level of the pool from which they were drawn.

---

[1] Advance Science Studies, 1959 Report. Thayer Academy. Braintree, Mass. page 8.

Since the group means and standard deviations are not particularly informative for descriptive purposes, percentiles based on national norms are reported both here and in the following section. These data clearly indicate that most of the participants were from among the top 10% of the school population in terms of several measures of scholastic aptitude.

Table II

Descriptive Statistics of Candidates and Participants

Part I

All Candidates Tested for Admission

OTIS SELF-ADMINISTERING TEST - FORM B
Range from 144 (IQ) to 89 with a median of 121

AMERICAN COUNCIL ON EDUCATION PSYCHOLOGICAL EXAMINATION, FORM 1948

Range in Q (Quantitative)	Percentile 99+ to 23, median of 75
Range in L (Linguistic)	Percentile 99+ to 17, median of 81
Range in T (Total)	Percentile 99+ to 13, median of 84

COOPERATIVE SECONDARY SCHOOL MATHEMATICS EXAMINATION, FORM S
Range in percentile 99+ to 10, median of 60

Part II

The Participants

OTIS SELF-ADMINISTERING TEST - FORM B
Range from 144 to 119, median of 127

AMERICAN COUNCIL ON EDUCATION PSYCHOLOGICAL EXAMINATION

Range in Q (Quantitative)	Percentile 99+ to 48, median of 91
Range in L (Linguistic)	Percentile 99+ to 46, median of 91
Range in T (Total)	Percentile 99+ to 60, median of 93

COOPERATIVE SECONDARY SCHOOL MATHEMATICS EXAMINATION, FORM S
Range in percentile 99+to 37, median of 87.

Pre-test Data: Some of the test data collected during the first few days of the institute are also useful for getting a general idea of the science and mathematics ability and interests of the group. These data are summarized in Table III. It should be recalled that both the form and the percentile norms for the STEP tests are for college freshmen. The Kuder Vocational Interest norms are for the "general population".

Table III

Science and Mathematics Ability and Interest

	Means	Std. Dev.	Percentile Range		Percentile of Means
			-1σ	$+1\sigma$	
STEP Tests					
Science	42.5	5.2	88	98	—
Mathematics	36.9	5.0	96	99	—
Kuder Preference Scales					
Mechanical	37.6	12.8	8	59	26
Computational	32.1	8.8	29	94	71
Science	55.6	8.3	74	99	95

This table indicates the high ability in science and mathematics of this group of students. The Kuder interest scores are high on science, relatively high on the computational scale, but are surprisingly low on the mechanical scale. A high score on mechanical would indicate interests similar to people in various types of engineering, at least at the professional level.

Student Changes

Changes In Ability: One of the primary goals of the program was to increase general competence in science and mathematics. As explained in Chapter II, the Sequential Tests of Educational Progress (STEP) for science and mathematics seemd most appropriate for evaluating these objectives. The t-test for correlated distributions was used to determine whether or not it would be possible to attach significance to the observed differences. These results are summarized in Table IV.

The tests showed a significant increase in the STEP Science means, but the small difference between the STEP Mathematics means was probably due to sampling error. There were probably several factors which contributed to this difference between the changes on the science and mathematics tests.

The main factor was revealed by our direct observations of the student experiences. The heart of the program was undoubtedly the eight-weeks of laboratory research and the STEP Science has face validity for measuring the abilities which those experiences would tend to develop (i.e., ability to screen hypotheses, interpret data, reason quantitatively, etc.) The developed abilities assessed in the STEP Mathematics on the other hand, would not be expected to be particularly affected except during the brief two-week institute at the beginning of the program. Even, then, mathematics was a minor component except for those students who were in the mathematics section (see Chapter I for a description of the four sections). However, the STEP means for the mathematics section alone did not increase significantly either.

Another possible reason for the STEP Mathematics result was student fatigue. The two ninety-minute STEP tests were given on the day that the students were to turn in their eight-week paper, and many had apparently worked long on those the night before that post-test session. Furthermore, the math test was administered after the science test, and the two tests in one session might have been too much for them. At any rate, we have no sound basis for saying that the students improved in mathematical competence.

It should be pointed out that these results are somewhat ambiguous because of the lack of a control group in our investigations. A significant value of t in this case makes it possible to deny that the students remained unchanged during the ten-week period[1], but it is not possible to conclude definitely that the summer "treatment" was solely or even primarily responsible for detected improvements in group means.

Table IV

Tests of the Significance of Pupil Gain

Instrument	Pre-test Means	Post-test Means	Std. Er. Diff.	t	p
FAS Total	60.49	63.45	.540	5.48	p<.0005
FAS Part I	29.95	31.15	.311	3.86	p<.0005
FAS Part II	30.55	32.31	.213	3.82	p<.0005
STEP Science	309.65	314.40	1.47	3.23	p<.005
STEP Math	308.24	307.64	.853	-.703	not signif.

The values in the table are one-tailed probabilities since student gain was hypothesized. The differences between the variances of these distributions were checked and none were found to be significant. This, together with the fact that the distributions were all normal, makes it possible to discuss the significant t's in terms of the mean differences.

Changes in Perceptions of Science and Scientists: Although the Facts About Science test was designed for less able students than those attending the Thayer Program, it seemed to be the best instrument available for evaluating the program's success in promoting a better understanding of the scientific enterprise and the roles of scientists. Therefore, we decided to try the FAS and then use this experience as a partial basis for the development of an improved instrument to be used in subsequent investigations.[2]

---

[1] Practice effects being negligible on the two different forms.

[2] The Principal Investigator and Mr. Leopold Klopfer are currently developing such an instrument, to be called the "Test on Understanding Science". It is expected to be available by the summer of 1961.

The change in student performance on the FAS test was indeed remarkable. Using the t-test for correlated observations, the post-test means were found to be significantly greater than the pre-test means ($p < .0005$) on the total test score and on both sub-scales, science and scientists. (Examples of items describing the two scales are presented below.) See Table IV for a summary of these computations. As in the case of the STEP Science results, the lack of a control group makes it impossible to attribute this change solely to the ten-week treatment, but it can definitely be claimed that the students did improve in the post-test administration. This result also tends to support the validity of the FAS, since students who were exposed to reality (science and scientists) for two months, tended to change to the "best" response in the multiple choice items.

Having established (by use of the t-test) an over-all change toward the test maker's desired answer, the next step was to identify those particular items in the test for which that change was greatest. This was accomplished by use of McNemar's chi square test for correlated frequencies.

To give the reader a general idea of the nature of the FAS and also to illustrate the types of changes in responses which were observed, eight of the items (four each on science and on scientists) and their results are presented below. The number of students who selected each alternate in the pre-test, followed in parenthesis by the frequencies for the post-test are listed after the three alternative answers. Below the item are the results of the McNemar test. For example, the first item listed is item 42 in the FAS. Thirty-seven students picked (A) in the pre-test . and fifty-three students picked (A) in the post-test. Of the fifteen students who changed their responses, all moved to answer (A). If the changes were random, we would expect as many tallies in the upper left cell as in the lower right cell of the four-fold table. The totals in the table will be different from those next to the alternate whenever a student does not answer a question in either the pre- or post-test. The correct answer to each question is indicated by placing its letter in parentheses.

Table V

Changes in FAS Item Responses

Items on Scientists

42. Children of scientists generally enjoy spending time with their fathers because
    - (A) most children enjoy spending time with their fathers. 37 (53)
    - B. scientists are able to tell their children exciting stories. 4 (0)
    - C. scientists are able to help their children build things. 13 (2)

		Post-Test		
		B & C	A	
Pre-test	A	0	37	37
	B & C	2	15	17
		2	52	54

Chi square = 13.07

$p < .001$

53. Three men all work for the same drug firm. The first is a research scientist, the second is a plant foreman, and the third is a salesman. The answer to which of the following questions would help you select the research scientist?
    - (A) Which man has had the most college training? 44 (55)
    - B. Which man is the hardest worker? 2 (0)
    - C. Which man is the most serious-minded? 9 (0)

		Post-test		
		B & C	A	
Pre-test	A	0	44	44
	B & C	0	11	11
		0	55	55

Chi square = 9.09

$.001 < p < .01$

40. On his vacation, a scientist is most likely to
    A. visit a scientific exhibit. 12 (4)
    (B) take a trip around the country. 29 (42)
    C. study a different branch of science. 13 (8)

		Post-test		
		A & C	B	
Pre-test	B	3	26	29
	A & C	9	15	24
		12	41	53

Chi square = 6.72

$.001 < p < .01$

36. More security risks have been discovered among scientists than among historians because
    (A) a greater number of scientists have been investigated. 36 (45)
    B. scientists are more easily influenced by subversives. 6 (6)
    C. many scientists have been educated abroad. 12 (4)

		Post-test		
		B & C	A	
Pre-test	A	2	34	36
	B & C	7	11	18
		9	45	54

Chi square = 4.92

$.02 < p < .05$

Items on Science

34. Of the following, which is the most important characteristic of science?
    A. As many facts as possible are acquired and classified. 21 (7)
    B. Statements are not made unless absolutely true. 1 (3)
    (C) Its own mistakes are discovered and corrected. 33 (44)

		Post-test		
		A & B	C	
Pre-test	C	1	31	32
	A & B	9	13	22
		10	44	54

Chi square = 8.64

$.001 < p < .01$

17. It is the duty of all scientists to
    A. tell us how we should use their discoveries. 19 (7)
    (B) report their discoveries in such a way that others may repeat their experiment. 36 (48)
    C. be as economical as possible, since scientific experiments are often very expensive. 0 (0)

		Post-test		
		A & C	B	
Pre-test	B	2	34	36
	A & C	5	14	19
		7	48	55

Chi square = 7.56

$.001 < p < .01$

49. In the long run, the increased use of automatic machines in factories will tend to
    A. put people out of work. 20 (10)
    (B) make more jobs. 35 (44)
    C. increase the cost of the product. 0 (1)

		Post-test		
		A & C	B	
Pre-test	B	1	34	35
	A & C	10	10	20
		11	44	55

Chi square = 5.82

$.01 < p < .02$

78. The study of animals is important to the science of medicine because
    (A) it tells us a great deal about how our bodies work. 49 (55)
    B. it makes it easier for us to get rid of animals that cause human disease. 1 (0)
    C. it enables us to make vaccine from animal serum. 5 (0)

		Post-test		
		B & C	A	
Pre-test	A	0	49	49
	B & C	0	6	6
		0	55	55

Chi square = 4.17

$.02 < p < .05$

One frequently used theme in the FAS is that scientists are "regular guys". This theme is illustrated in the scientist items given above and in most of those items which showed significant shift. It is hard to tell whether this was a conclusion the students reached as a result of their summer's experience or whether they were "brain -washed". For instance, in newspaper articles publicizing the program, one of the mentioned goals was to show the students that scientists are human beings. In whatever way the theme was communicated to them, it was certainly accepted. In fact, it was carried to an extreme as illustrated in item 61.

61. In general, scientists are
    A. below average physically but above average mentally. 24 (10)
    (B) better than average physically and mentally. 18 (17)
    C. average physically and average mentally. 13 (27)

		Post-test		
		A & B	C	
Pre-test	C	2	11	13
	A & B	25	15	40
		27	26	53

Chi square = 8.47

$.001 < p < .01$

The tendency not to pick (B) in this item is also due to the unfortunate common stereotype that mental ability and physical fitness are negatively correlated, but the "regular guy" theme certainly operated here to produce the ten-week change.

In addition to item 61, two others showed significant shift away from the "correct" answer. These two cases possibly illustrate invalid items rather than misguided youth, however. These results are tabulated below. For both items, the desired response was (A). The difficulty of constructing an instrument like FAS can be seen in these examples.

10. Which one of the following characteristics would be most likely to interfere with a scientist's everyday work?
    (A) "Absent-mindedness" 41 (31)
    B. Inability to read foreign languages 10 (19)
    C. Radical political opinions 4 (5)

		Post-test		
		A & C	B	
Pre-test	B	3	7	10
	A & C	33	12	45
		36	19	55

Chi square = 4.27

$.02 < p < .05$

22. Which of the following problems is the best example of pure science?
    (A) A study of marriage and courtship patterns among South Sea islanders. 5 (5)
    B. The development of a design for a new bridge. 13 (7)
    C. Writing an equation to describe the shape of a cloud. 37 (45)

		Post-test		
		A & B	C	
Pre-test	C	2	35	37
	A & B	8	10	18
		10	45	55

Chi square = 4.08

$.02 < p < .05$

__Changes__ __in__ __College__ __Plans__ __and__ __Career__ __Goals__: One great advantage of the type of program in which students actually go into research laboratories and see "science in action" is that it has tremendous potential as a vocational guidance device. In the complex technical society of modern America many possible vocations are essentially unknown quantities to high school students. They usually have only popular stereotypes with which to operate in their career decision making, and these are frequently distorted. To determine the effects of this program on the vocational choice process, the college and career plans of the participants were determined at three check points during and after the summer program. In this particular section of the report, follow-up observations are included in addition to those made during the summer.

A comparison of the student's stated plans for college at the end of the summer and the following spring with those which he had described at the beginning of the summer indicates that much change had taken place. Between June and the following March, nearly half of the students had indicated a change of their first choice for college. At least half of these students indicated that the summer's program had played a major factor in this change. Many students indicated that during the summer they noted that scientists and engineers benefited from a strong liberal arts background. Thus, for some students a change was affected towards a college or university reputed to offer a more challenging liberal arts program. Ten of the twenty-six students who had previously indicated their desire to go to a large technical institute, subsequently changed their choice to a smaller, more personal, liberal arts college. It is interesting to note that some of the students who actually had worked at one particular technical institute during the summer had been advised by the professors with whom they worked to go elsewhere for their undergraduate education in order to get a better liberal arts background, and in order to have a better chance of being accepted in the institute's graduate program.

Together with this move toward a liberal arts background, was a general career goal movement from the applied sciences toward a greater interest in basic sciantific research and college teaching. Table VI summarizes the changes in career goals revealed in statements obtained at the three check points. Horizontal arrays describe the career goal areas at the beginning of the program, and the vertical arrays catagorize statements made one year later. An individual is represented in this two-dimensional scheme by an M or F, designating male or female. For those changes which were already evident at the end of the summer, the letter is placed in parentheses. Subscripts T and R are used if change included a stated shift toward teaching (T) or research (R). When teaching or research were mentioned as new special interests, it was voluntary, for the students were not specifically asked about these two areas. Therefore, the shift towards teaching and research may be greater than is indicated here.

As twenty-six of the fifty-five students are located off the "no change" diagonal in Table VI, about one-half of them had changed the general area of their career goal. The movement toward basic sciences, research and teaching is seen by inspecting the off-diagonal cells. An unexpected outcome of this program is the increased interest in teaching at the college level. The students now see this type of position as offering one of the best ways for having time to conduct pure research.

The three heading toward medical careers remained firm in their convictions, although even there an interest in research became evident. The three students in the lower right of the table (uncertain and non-science) are girls. The table does not, of course, show the movement which took place within areas (e.g. chemistry to physics). Even where no changes occurred, there seemed to be a general clarification of career goals which the students themselves ascribed to the program. These trends substantiated those which were indicated in the follow-up questionnaire to the 1958 participants.

As the career interests changed from the more applied to the basic research sciences, this factor was noted in the present plans which the students have made for their college majors. There was only one case of a student's interests moving in an opposite direction to this general trend. This boy had been advised by a chemical engineer, who was a friend of the family, that a preliminary preparation in the field of engineering offered a high probability of financial reward and that subsequent to this preparation one could try the field of basic research and still have a "cushion" to fall back upon if he were not successful in research. Such is the process vocational psychologists are trying to predict!

Table VI

Career Goal Changes

Pre-Program Goals	Post-Program Goals								Totals
	Medical	Engineer	Sci-Eng.	Basic Sciences	Sci-Math	Math	Uncertain	Non-Science	
Medical	F_R M F								3
Engineer		M_R M_R M M	M	M M $(M)_T$ M_T					9
Sci-Eng.		M M		M_{TR} M_R		M M_{TR}			6
Basic Sciences		M		MMMMMMM $M_R M_R M_R M_R$ $M_R M_T M_{TR}$ F $F_R (F)_R (M)_R$	M		M_T		21
Sci-Math				M_R $(M)_T$ $(F)_R$		M_{TR} M			5
Math			M_T		(M)	M_T M	M		5
Uncertain				M	M_R		F	F	4
Non-Science				M_{TR}				F	2
Totals	3	7	2	29	3	6	3	2	55

Stated Reasons for Change: At the end of the 10-week program the students responded to a questionnaire in which they were asked to assess the relative effectiveness of various aspects of the program. The questions were asked right after they had taken the post-test battery and were in terms of specific behaviors as measured by the tests. The questions and results are as follows:

1) Assuming we detect an improvement in your performance on the STEP Science test, what do you feel had contributed to this improvement? (Rank the following possibilities in order of contribution: 1, 2, 3, etc. Rank only those items which you feel may be related to any possible improvement.)

Number of 1st places	Aspect of program
19	The first two weeks of classes here at Thayer.
0	The nine Wednesday evening meetings.
14	The help you received directly from the scientists and engineers with whom you worked these past eight weeks.
16	The actual laboratory work itself, and the necessary reading done in connection with it.
1	Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.
50	Number of students who felt that some aspect(s) of program affected abilities measured by STEP Science test.

2) Assuming we detect an improvement in your performance on the STEP Mathematics test, what do you feel has contributed to this improvement?

Number of 1st places	Aspect of program
20	The first two weeks of classes here at Thayer.
0	The nine Wednesday evening meetings.
5	The help you received directly from the scientists and engineers with whom you worked these past eight weeks.
8	The actual laboratory work itself, and the necessary reading done in connection with it.
4	Extra mathematics reading, stimulated by the program in general, but not necessary to your laboratory project.
37	Number of students who felt that some aspect(s) of program affected abilities measured by STEP Mathematics test.

3) Assuming we detect changes in your responses to the Facts About Science test, what do you feel has contributed to this change?

Number of 1st places	Aspect of program
3	The first two weeks of classes here at Thayer.
2	The nine Wednesday evening meetings.
36	The help you received directly from the scientists and engineers with whom you worked these past eight weeks.
10	The actual laboratory work itself, and the necessary reading done in connection with it.
1	Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.
52	Number of students who felt that some aspect(s) of program affected general perceptions of science and scientists.

4) What aspects of this program helped in clarifying or perhaps even changed your career goals and your plans for realizing that goal?

Number of 1st places	Aspect of program
9	The first two weeks of classes here at Thayer.
0	The nine Wednesday evening meetings.
16	The help you received directly from the scientists and engineers with whom you worked these past eight weeks.
25	The actual laboratory work itself, and the necessary reading done in connection with it.
0	Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.
50	Number of students who felt that some aspect of program affected their career plans.

The above distributions of first place ranks agree remarkably well with our own observations of what aspects of the program would be effective for producing particular types of changes. Also note that the least expected changes were in abilities measured by the STEP Mathematics test. This, of course, was simply a matter of program emphasis.

The greatest concensus among the students was in regard to changes in their perceptions of science and scientists, as measured by the FAS. There is little doubt that the best way to show students what science and scientists are like is to put them in direct contact with working scientists, and this was acknowledged in the student responses.

Personality and Environmental Factors

Interest-Temperament Discrimination: One of the tasks of the Scientific Career Study (SCS) is the investigation of the extent to which relationships can be found between certain types of personality information and entrance into scientific careers. One of the five age groups included in that study is identical to the Thayer group. The 200 students who comprise that particular age sample were randomly selected from among the college-bound eleventh graders of nine high schools representative of those sending students to the Thayer program. This presented an ideal opportunity to make comparisons between certain groupings of the SCS subjects and the Thayer participants.

One early and interesting finding of the SCS is that interest, as measured by the Kuder[1], and temperament, as measured by the G-Z Temperament Survey[2], distinguished (to a highly significant degree) between students heading toward science type careers from those who were not. The details of that analysis cannot be gone into here[3], but a brief description is necessary in order to explain what was done with the Thayer data.

---

[1] *Kuder Preference Record*. *Vocational*. *Form CH*. Published by Science Research Associates, Chicago, Ill.

[2] *Guilford-Zimmerman Temperament Survey*. Published by Sheridan Supply Co., Beverly Hills, Calif.

[3] Details of this analysis can be found in the interim report: Cooley, W.W. op. cit.

The Kuder and G-Z each yield ten scores. If these twenty scores are considered as coordinates in a twenty dimensional test space, each student has a unique location when plotted in that test space, depending upon the interest-temperament information contained in the original test scores. It is "awkward" to think about and deal with spaces of twenty dimensions, but fortunately procedures of multivariate analysis are available for reducing the number of dimensions, depending upon the purpose of the analysis. If the problem is to distinguish the Potential Scientist Pool (PSP) from those students not heading toward scientific careers, the interest-temperament test space can be reduced to a single discriminant function. Instead of having to deal with twenty scores, the student's position along this new axis (i.e. his discriminant score) contains most of the original information about the difference between the PSP and non-PSP. Table VII gives the relationships between the original twenty variables and the resulting discriminant function. A high discriminant score indicates a tendency to be in the potential scientist group, so high positive correlations indicate variables related to movement into scientific careers.

Table VII

Correlations of K-GZ Scales With Discriminant Score

Kuder Interest Scales	Correlation (N = 195)
1. Outdoor	.12
2. Mechanical	.11
3. Computational	.36
4. Scientific	.79
5. Persuasive	-.54
6. Artistic	-.33
7. Literary	-.08
8. Musical	-.17
9. Social Service	.11
10. Clerical	-.11

Table VII - cont'd.

Guilford-Zimmerman Scales	Correlation
1. General Activity	.11
2. Restraint, Seriousness	.47
3. Social boldness	.24
4. Social interest	.11
5. Emotional Stability	.15
6. Objectivity	.18
7. Friendliness	.12
8. Thoughtfulness	.54
9. Personal Relations	.05
10. Masculinity	-.18

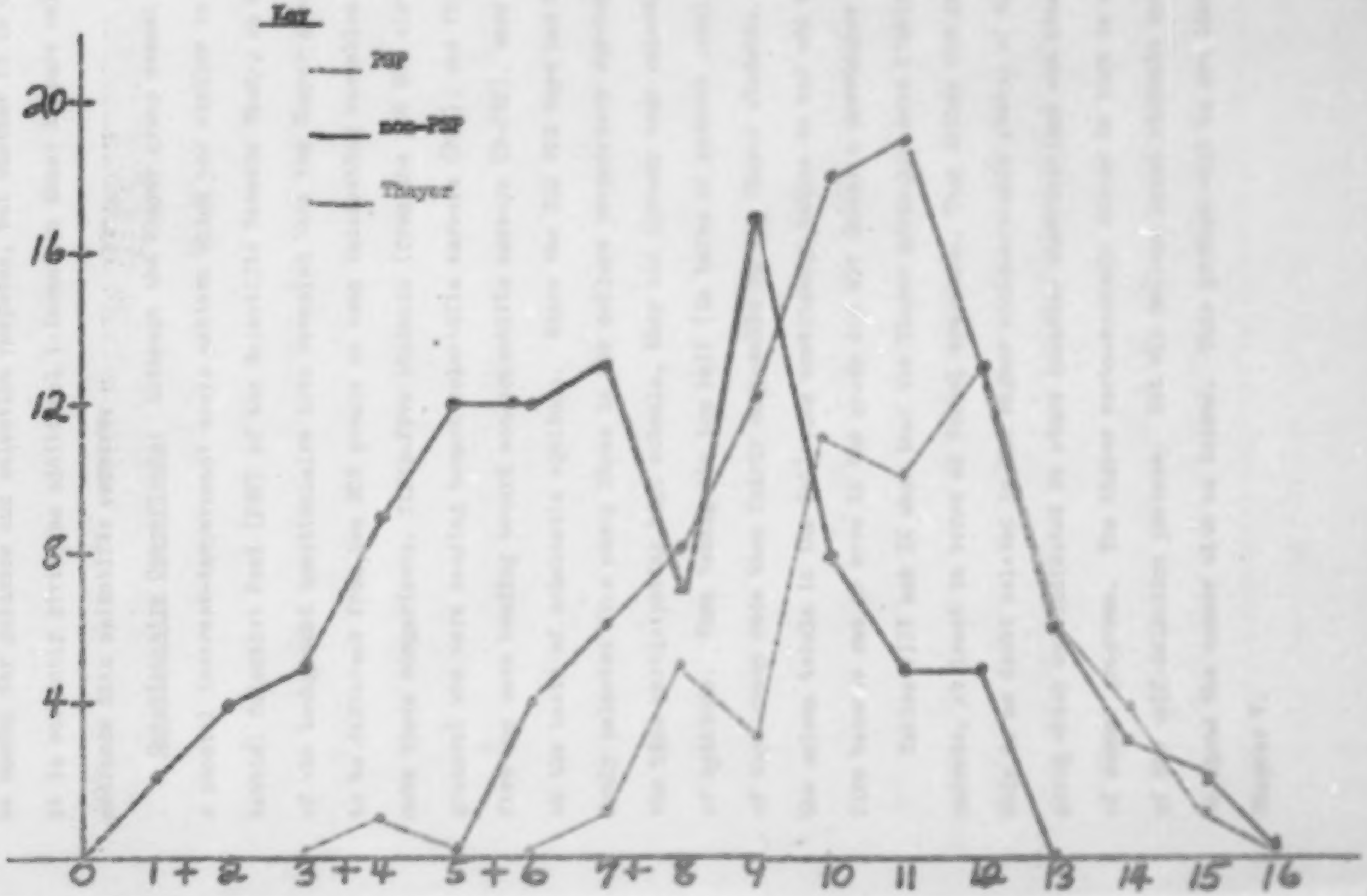
A difficulty with multivariate analysis is that small samples tend to yield equations which are peculiar to that sample. As a check on the SCS results it was decided to compute the interest-temperament discriminant scores for the Thayer group (using the weights obtained from the SCS discriminant analysis) and see if they would tend to lie on the PSP end of that function. The results are represented as three frequency polygons in Fig. I.

There is a definite tendency for both science groups to be high on the discriminant function, with the Thayer group tending to be higher than the PSP. The students in the two science groups who have low discriminant scores would be more likely to change their career goal to a non-science area if these personality attributes are functionally related to the career development process, and we suspect they are. The degree of commitment to a scientific career for the Thayer students was independently arrived at by our interviewer, and these ratings were positively related to the student's discriminant score.

Although more rigorous checks on the validity and utility of these initial results are built into the five-year SCS, these findings look promising. This discrimination between future scientists and non-scientists is better than that which would be obtained by using any one of the

Figure I

Discriminant Scores for Three Groups



original twenty variables alone. This type of information might eventually be useful for guidance and selection purposes, but whether it is or not, it is currently giving us additional information about factors related to entrance into scientific careers.

Questionnaire Comparisons: Although the Thayer group seemed to have a general interest-temperament score pattern which was similar to the Potential Scientist Pool (PSP) of the Scientific Careers Study, an analysis of the background questionnaire data revealed that the Thayer group tended to be different from two SCS groups on some interesting variables. To make these comparisons, fifty-five students (from the 200 SCS eleventh graders) who were heading toward scientific careers (PSP), and fifty-five who were heading toward non-scientific careers (N-PSP), were selected on the basis of scholastic aptitude. Since the 200 SCS boys had been randomly selected from among those in the college preparatory curriculum of the nine participating high schools, they had already been selected in terms of aptitude. Then taking the top half (in terms of general intelligence) of that group made them fairly comparable to the Thayer students. Some of the column totals in the following contingency tables do not add to fifty-five because one or more in the group did not answer a particular question.

Tables VIII and IX show that the Thayer group had more highly educated parents, at least in terms of formal education, than either SCS groups. This is no doubt related to the higher socio-economic status of the Thayer group which was indicated in other question distributions and other studies of summer programs. The higher socio-economic status in turn is a function of the self-selection process. Not all college bound students can afford to spend the summer with no income. This problem will be considered in Chapter V.

The Thayer students tended to associate more with college bound friends. This is demonstrated in both Tables X and XI. The Thayer trend is in the same direction as is the difference between the PSP and N-PSP, but the tendency is more pronounced in the Thayer group.

Two trends which have frequently appeared in comparisons of scientists and non-scientists concern sibling position and family religion. Scientists tend to be the oldest sibling and/or oldest son, and the proportion of scientists who are Catholic is smaller than the proportion of Catholics in the general population. Both the Thayer and PSP groups differed from the N-PSP in those respects, and the Thayer trend was greater. These data are in Tables XII and XIII.

Three questions regarding extra-class activities resulted in significantly different distributions for the three groups. The Thayer students tended to belong to more school clubs (Table XIV) and were more frequently officers in those clubs (Table XV) than were the SCS groups. Both the PSP and Thayer groups tended to participate less frequently in athletics than the non-science group, and again the Thayer difference was greater (Table XVI).

The club membership and leadership tendencies of the Thayer group may have resulted partly from the selection process. In the admissions interviews, the Thayer staff looked especially for students who would not be difficult personnel problems when placed in the cooperating laboratories. Also, the teachers tended to recommend the more active students to the program.

It should be pointed out that the nine females in the Thayer group do not affect the chi square results in the above tables. Removing the girls does not change the nature of the Thayer distributions nor the probabilities associated with their independence.

In general, the chi square results and the interest-temperament results in the previous section tend to demonstrate that the Thayer group differs from the non-scientists in the same direction as the PSP differs, but that the Thayer differences are greater. Where the Thayer trends are different from Both SCS groups, self-selection and staff admissions practices tend to explain those differences. If the observed scientist:non-scientist differences actually operate in the career choice process, the Thayer group would seem to contain a larger proportion of future scientists than does the "scientist" group of the SCS. An examination of the movement out of the PSP during the following school year on the part of the SCS students tends to validate that hypothesis. We intend to follow both groups over the next three years and it will be interesting to determine whether or not tendencies to move out of the PSP can actually be anticipated from data available five years earlier.

Table VIII

Father's Education

Thayer	N-PSP	PSP	Total	
11	29	23	63	Finished high sch. or less
15	10	11	36	Some college or tech
26	15	20	61	Finished college
52	54	54	160	Total

Chi square = 12.72

ndf = 4

$.01 < p < .02$

Table IX

Mother's Education

Thayer	N-PSP	PSP	Total	
19	31	32	82	Finished high sch. or less
18	10	10	38	Some college or tech
17	11	12	40	Finished college
54	52	54	160	Total

Chi square = 9.54

ndf = 4

$.02 < p < .05$

Table X

Number of Peers Planning College

Thayer	N-PSP	PSP	Total	
2	11	7	20	Few
35	36	40	111	Most
18	6	7	31	All
55	53	54	162	Total

Chi square = 10.10

ndf = 4

$.02 < p < .05$

Table XI

College Plans of Best Friends

Thayer	N-PSP	PSP	Total	
46	20	28	94	College definite
7	20	21	48	Probably
1	5	2	8	Planning not to go
1	8	2	11	Don't know
55	53	53	161	Total

Chi square = 30.40

ndf = 6

$p < .001$

Table XII

Number of Older Siblings

Thayer	N-PSP	PSP	Total	
39	28	31	98	None
16	27	23	66	1 or more
55	55	54	164	Total

Chi square = 4.81

ndf = 2

$.05 < p < .10$

Table XIII

Family Religion

Thayer	N-PSP	PSP	Total	
26	24	23	73	Protestant
13	27	25	65	Catholic
14	3	3	20	Jewish
53	54	51	158	Total

Chi square = 17.4

ndf = 4

$.001 < p < .01$

Table XIV

Membership in School Clubs

Thayer	N-PSP	PSP	Total	No. of Clubs
7	22	20	49	0
7	13	12	32	1
18	14	10	42	2
10	3	8	21	3
13	3	5	21	3+
55	55	55	165	Total

Chi square = 24.6

Ndf = 8

$.001 < p < .01$

Table XV

Officer in School Clubs

Thayer	N-PSP	PSP	Total	
26	46	41	113	No
29	9	13	51	Yes
55	55	54	164	Total

Chi square = 19.46

ndf = 2

$p < .001$

Table XVI

School or City Athletics

Thayer	N-PSP	PSP	Total	
36	19	26	81	No
19	36	29	84	Yes
55	55	55	165	Total

Chi square = 10.87

ndf = 2

$.001 < p < .01$

Student "Success" In the Program

One question which repeatedly presented itself in our observations of the summer program was: What personal attributes are related to individual success at this program? The answer to that question would not only be interesting, but would also have practical utility in the consideration of applicants for future programs. The problem, of course, is the definition of an operational success criterion.

One possible procedure might have been to develop a success scale by combining several indices of success based on measurements of desirable changes which were observed to have occurred and also a quality rating of the student's eight-week research report. Such a combination criterion proved to be extremely difficult to develop, so a different tack was taken. We decided to request the four supervisors who worked with and observed the students over the ten-week period, to rate each student according to the degree of student accomplishment.

The directions for the raters are included in the Appendix so that the reader can determine exactly what the supervisors were asked to do. Essentially, their job was to locate the students along a 10 point success criterion, assigning the students primarily on the basis of their eight-week laboratory accomplishments. Unfortunately, each of the four raters did not come into contact with every student, so a confident estimate of the reliability of the ratings is not possible. Inspection of the cases where overlap did occur showed that between-rater agreement was considerable if the original scale was reduced to a three-point index, indicating whether the student was in the top quarter, bottom quarter, or middle half of the success continuum. The resulting three-point success criterion was used in three multiple correlation analyses.

The three different sets of independent variables used were: aptitude and ability, temperament, and vocational interests. There were two main reasons for conducting these analyses. One was to determine whether or not test score information available at the beginning of the program would be useful for more refined selection techniques. Also, we were interested in knowing the relative extent to which personality, interest and ability factors were considered important by the Thayer staff.

The results of these analyses were very disappointing. Table XVII presents the relationships between the rated success criterion and the three systems of data. None of the multiple correlations are significant at the .05 level. There are no doubt several reasons for this lack of relationship between the criterion and the sets of predictors. The main one is that generalized success ratings are just not reliable, and even when they are, too many variables are considered by the rater and the resulting criterion is based upon extremely heterogeneous factors, weighted differently for different cases. Such a criterion is not predictable using linear correlational procedures.

A better procedure might have been to have the supervisors indentify students who turned out not to be qualified for the program for particular reasons, classify these poor risks according to their liabilities, and then use discriminant analysis to see if test score data could be used to identify the undesirable students. This would tell us which attributes were considered important by the staff and also provide information for improving screening techniques, at least for screening in terms of what the staff wants.

The beta weights are not presented in Table XVII since no confidence can be placed in the observed relationships. Only one zero order correlation between the individual predictors and the success criterion was significant (Kuder persuasive scale), but since twenty-six r's were computed, this was possibly a chance relationship.

Table XVII

Multiple Correlations With Rated Success Criterion

Independent Variables	Mult. R	F ratio	Probability
Ability: STEP Math and Science, FAS, Otis, Coop Math. (5 scores)	.32	1.09	$> .05$
Temperament: Guilford-Zimmerman Temperament Survey (10 scores)	.28	.44	$> .05$
Interest: Kuder Preference Record-Vocational	.50	1.66	$> .05$

Personal Observations

The previous "relationship-seeking" efforts of this chapter are perhaps important as we begin to develop relaible bases for decision making, but thoughtful observations by interested individuals are still important in program evaluations of the type attempted here. The following discussions should give the reader some insights into the program not available in the previous tables. They include the reactions of the cooperating scientists and a few of our own personal observations.

The Reactions of Scientists: When the students were visited at their different research laboratories during the summer, it was often possible to talk informally with the cooperating scientists. At the conclusion of the program, Thayer Academy requested that each scientist submit an appraisal of his student's performance. By combining these remarks, it is possible to obtain the scientists' general reactions to this program.

Comments similar to the following, made by a university chemistry professor, were common: "In my opinion the research participation type of summer program is by far superior to the course type of program and I hope that in the future the National Science Foundation will emphasize this sort of program even more than had been done in the past." A general expression of amazement was expressed that students of this age could exhibit such a high calibre of insight and perform so well. Their level of work was reported to generally exceed that expected of the typical college student. There was no evidence of there being a general animosity or resentment of employees to these students. Indeed, one scientist reported that "the student worked so well with older workers in the laboratory that they were easily able to accept him as a colleague rather than as a supernumerary or young dilettante". Another scientist was sorry to lose his able luncheon "bridge partner"! Without exception, it was reported that these students had benefited from this experience.

Of equal interest are comments which suggest that others, too, had benefited. "We accomplished", reported one scientist "some valuable tests that otherwise would have gone undone for lack of time. The profession as a whole gains because these students undoubtedly have a better conception of what they may or may not be expected to do as a professional person in the engineering or scientific field. Thus, the program would tend to reduce the number of misfits." Another scientist reported the "refreshing opportunity to see the jobs which sometimes seem routine or frustrating". Still another: "He has contributed to our understanding of the problem." And: "It would not be an exaggeration to say that his intensity and enthusiasm have made the Summer somewhat more enjoyable for most of those who associated with him."

Does the time required to guide and instruct these students curtail the normal activity of a laboratory? Since only one student was assigned to a given scientist, the one hour per day that was generally spent working directly with the student did not seem to interfere with normal operations. Exampleshave been cited where the student actually contributed to the laboratory's productivity. Scientists were anxious to point out, however, that this such contribution should not be a criterion demanded of the program.

Although no major criticisms or general recommendations were made concerning this program, several comments bear noting. A few reported that too much of the student's time was spent in collecting and preparing data for his final report required by Thayer Academy. Not disputing the value of this report, it was felt that some of this time might have been better used to acquaint the student with additional laboratory experiences. Some students were noted to be actually performing work of a more applied than pure research nature, yet it was generally recognized that most students had been given an insight into the mechanics of pure research that went beyond the normal exposure given most laboratory technicians. One university professor felt that the cost of chemicals provided his student might have been underwritten by the program. This was the only comment concerning a financial liability imposed by the program.

The enthusiasm which the majority of scientists reported in their appraisals may be noted in the following: "My summer student, (......), has done a superb job on his project. I have been led by the Thayer Staff to have very high expectations from this boy, but I must admit that even these have been exceeded. He has accomplished a great deal of work this summer, which promises to be of extreme value to us. His industry and integrity in the work would be a credit to any scientist. I was more than impressed with the rapidity with which he grasped the concepts upon which the work is based. He apparently has done a considerable amount of thinking about his project away from the laboratory and showed great ingenuity in overcoming a number of rather difficult obstacles in the research. I have shown his report to a number of qualified people, and they rated it as a fine job done by a graduate student from one of the local universities. They were astounded when informed that this was the work of a 17-year old boy between his junior and senior year in high school. I may reiterate that I find it a bit hard to believe it myself although I have had eight weeks watching him in action."

Because of the proximity which these students had to these laboratories the following school year, it may be noted that most students had some subsequent contact with these scientists. Nine students were employed in these same laboratories during the following summer. One student accompanied his scientist and family on a tour of the Western states in the following summer. No scientist indicated that he would not be willing to take another student from this program another year.

Observations by the Investigators: The personal observations and impressions gathered by the investigators serve to confirm and supplement data gathered from tests, questionnaires and interviews. The ivy-covered campus of this quaint New England private secondary school provided a unique setting for these students during the first two weeks of this summer program. As a result of recent renovations at Thayer Academy, students were provided with modern, well-equipped science and mathematics classrooms and laboratories together with a library of approximately 1000 volumes of advanced technical readings in science and mathematics. The combined secondary school and college staff were highly qualified to provide the extra demands of these talented students. The enthusiasm and candor with which these students discussed this program left little doubt as to their favorable response to the total program.

Whereas this program was established to provide for as many as 60 students, last minute drop-outs resulted in 55 students participating. The ratio of applicants to participants (5:1) is considerably less than that found at the national level (10:1). This discrepancy may be explained in part by the fact that the Thayer program is limited to a single grade level, and because the students were required to provide for their own transportation and housing. Preliminary screening at the schools was also a major factor in reducing the number of applicants.

Students responded favorably to the enriched and accelerated courses of study during the first two weeks of the program. Particular interest was expressed by students who studied physics from an historical approach. Although this first section of the program served to expose students to new areas of science and mathematics content, a more important and valuable contribution to the total program was the opportunity for students to develop a group-solidarity, a seriousness of purpose, and an image of what was to be expected during the following eight weeks.

The purpose of the evening lecture series was not always understood by the students. Here again a unique function seemed to be the chance to learn of the interdependence of the sciences, to broaden the student's horizons, and to have personal association with scientist working on the frontiers of science and mathematics. It was intended that this occasion also provide time for students to discuss and exchange personal experiences which had occurred during the previous week. Except for the few occasions where specific seminars were scheduled for this purpose, however, the exchange seemed to be between small groups of friends with similar interests.

The evening lectures were generally of a high caliber and of current interest. Even general topics like "Science versus Technology" and "Putting Research on Paper" were well received. Speakers were rarely criticized for talking "over the heads" of the students, indeed it was not uncommon to find that some failed to appreciate the sophistication of their audience! A greater effort toward developing a linking theme during the course of these evening lectures would be helpful.

The success of this program depends to a great extent upon the adequate placement of student with scientist for the eight-week laboratory session. In the majority of cases the Thayer supervisor had made arrangements with the scientist as to the nature of the research work to which the student would be assigned. Where students participated in ongoing research, there was less opportunity for students to participate in the "initiating and planning" of research as was to be one of the program's objectives. In many instances, this would seem to be an unwarranted, or at least an undesirable prerequisite to the cooperative arrangements between Thayer and the scientist.

On the other hand, too little planning may be undesirable. It is not enough for the president of a large corporation or chairman of a university science department to indicate a willingness to sponsor a student for the summer. Such agreement may result in the "assigning" of a student to a scientist who may have little knowledge about, or interest in the program. Where actual discussion had taken place between Thayer personnel and the scientist with whom the student was to spend the major part of his time, the ideal conditions resulted.

Approximately one-half of the students were eventually to work with scientists who did not hold Ph.D. degrees. Oftentimes, the research assistant provided more time, and assumed greater responsibility for these students than did the degree holder. Rather than to generalize as to which person is likely to offer the better association, it may be presumed that an ideal situation would be for a student to work with and observe a variety of "job descriptions" during the summer. Where scientists were on vacation, arrangements were usually made temporarily to reassign students in the same lab.

No conclusion can be reached about the merits of placing a student in a university versus an industrial research laboratory. The quality of equipment, availability of library resources, the flexibility of working time, opportunities to observe pure vs. applied research, etc. vary considerably. Of more importance is the interest and responsibility which a given scientist will assume. Industrial laboratories would be slight favorites if they offered the student opportunity for further employment and experience the following summer.

The summer's program concluded in a last day's symposium held at Thayer Academy. At this time scientists, former teacher, parents, and friends were invited. Each student prepared an oral presentation of his project for his respective subject-area group. Unfortunately this last day came during a stiffling hot and humid day so that some of the benefits of the concluding evening's program evaporated.

The length and pace of the program may suggest certain health risks. No evidence of major fatigue was noted during the summer, but in two instances, students reportedly returned to school unnecessarily tired. On the whole, scientists and students indicated that the program should *not* be shortened, and health precautions could possibly be taken at the time of screening applicants. Students showing previous habits of fatigue or frequent illness may well be excluded from the program.

In a geographical area such as Metropolitan Boston, where a sufficiently large number of research projects may be provided, the Thayer Program may serve as a prototype for the development of future programs for talented high school students.

Chapter IV

ANALYSIS OF FOLLOW-UP OBSERVATIONS

After ten weeks of highly specialized and individualized summer study, the fifty-five students at Thayer Academy returned in the fall to their more traditional class work. As described in Chapter II, the follow-up observations (student questionnaire, student and teacher interviews, and parent questionnaire) were directed toward determining the school situation to which the student returned and to detect possible ways in which the summer experience may have affected him during the following school year. The latter is extremely difficult, since reliable information regarding student pre-Thayer school behavior was unavailable, and a control group was not feasible. Therefore, in this chapter we do not attempt to statistically determine changes in student school behavior which resulted from the summer program, but rather describe and analyze the stated reactions of students, teachers, and parents. Those aspects of the student follow-up questionnaire and interview which dealt with college and career plans have been considered in Chapter III.

The Students

All but three students returned in the fall to the schools they had been attending as high school juniors. One student transferred from a public to a private school, and two began their freshman year at college in the Early Admissions Program. These three changes were not a direct result of the summer program, having been previously anticipated. (See Table I for the junior year distribution of students and type of school attended.)

Student Courses and Grades: A description of the extremely varied school situations of the students gives a picture of how the very talented in science and mathematics make use of their time during the last high school year. The summer's effects cannot be generalized, since a student's choice of courses and participation in non-academic activities are limited by what his school can offer.

A large number of the students did not elect enriched or accelerated science and mathematics courses where they were available as shown in Table XVIII. Many students were limited in the number of such courses they could take by school policy, and also from concern that a possible lower grade in an advanced course would be misinterpreted by college admissions boards.

Table XVIII

Course and Grade Distributions

Course	Number of Students*	Grade Distribution		
		A	B	C
Regular science	36	30	6	
Advanced science	25	13	8	3
Regular mathematics	14	10	4	
Advended mathematics	39	24	11	4

*Totals do not add to 55 as some students did not take courses, while others took two.

The majority of students were taking five full courses which met for five periods per week. (See Table XIX) Five students were found to be adequately managing six full courses, although one-third were taking only four full courses. Much of this variation can be attributed to school policy. Six of these seniors were successfully handling two science courses at once. Others reported they could not take courses of their choice because of scheduling difficulties. In order to get some indication of the challenge which some of these students are capable of handling if given the opportunity, the course schedule of one of the public school seniors is cited: College English IV (Honors), Advanced Math IV, Physical Science Study Committee Physics, Russian II, College U.S. History, and Latin IV. In this particular case, most classes met four times a week for 50 minute periods. At the time this student was interviewed, a B in Russian was temporarily preventing him from getting all A's! In spite of this course load, he was able to participate in non-academic activities, contradicting a reason often given for limiting the maximum number of courses.

Table XIX

Number of Courses Taken by Students

Full Courses	Number of Students
4	19
5	31
6	5

Any grade "improvement" in the senior year as a direct result of the summer's experience cannot be shown. All the students had high scholastic averages in their junior year leaving little room for improvement. Also, competition and course work in advance courses in the senior year might lead to poorer grades even though the caliber of work was equal or better. When students were asked by questionnaire specifically about grade improvement as a result of the summer, they tended to give the "correct answer" that the summer had helped raise their grades. However, in the interview, when asked about general effects of the summer program on their present studies (grades not specified), only one student volunteered, without probing, that the summer helped improve his grades. Nevertheless, student comments tended to show that the summer had had a good basic effect on school work. For example, several reported the program had enabled them to attack the solving of problems more "scientifically". Some remarked that their study habits had improved, and for others there appeared to be greater seriousness of purpose. There is no question that the two students who were accepted for early college admission were satisfied with their decision to omit their senior year. Both were on the Dean's list, and both found the Thayer Program to be particularly helpful in enabling them to make a transition from high school to college.

Student Attitudes: Few of the students were challenged by the course work of their senior year, as shown in Table XX. They were reluctant to express this dissatisfaction, however, and in many cases their teachers were not even aware of their boredom. Personality factors of social and emotional maturity used in screening the applicants to the Thayer program showed in the students' unwillingness to criticize or make derogatory remarks. None were involved in any severe disciplinary action in school. Restrictions on course selection previously mentioned and the slow progress of heterogeneous classes contributed to the lack of challenge. Three-quarters of the students were among the top three or four ranking students of their senior class, which often meant only one or two others were capable of working on the same intellectual plane in any class. Special provisions made for these pupils are discussed in the next section on teachers. Students were asked whether they would have preferred working independently of the class on an individual basis, or attending a regional science class made up of a group of similar interest and ability, in lieu of their regular class. Little consideration had previously been given to possibilities along this line, yet these suggestions met with general interest and curiosity.

Table XX

Student Reaction to Science and Mathematics Courses

	Percent of Students
Challenged	11%
Not challenged, but uncomplaining	86%
Not challenged, expressed boredom	13%
	100%

The amount of individual work permitted in science courses varied considerably. It appeared that those students electing Advanced Placement Courses in science, although kept busy with required assignments, actually had little opportunity for exploratory or creative laboratory work, or, indeed, little time for even reflective thinking. This will be considered more fully in the section on teachers.

Non-class Science Activity: Table XXI indicates the extent of student participation in non-class science activities. Many were using their free time to prepare science fair exhibits. Such activity was usually done outside of school time and was not generally considered to relate to work which was being done in school. In a few instances, students were able to utilize the facilities and equipment of the laboratories at which they had worked during the summer. Thirteen entered local or regional science fairs, and seven of the nine who went on to compete at the state level received some recognition. One-third of the students participated in the national Science Talent Search, and three were successful finalists. At least ten students attended schools where fairs were not held or national participation was not encouraged.

Twenty-three students participated in school science or math clubs, with six serving as club presidents. Few students spoke enthusiastically of the benefits from this type of activity, although some of the clubs seem to provide considerable challenge and interest. Again many schools do not offer such activities.

Table XXI

Students in Non-Class Science Activities

Students entering Science Talent Search	18	
Students entering science fairs and math contests	13	
Number of different students in above 2 activities		29
Students belonging to science clubs	23	
Number of different students in above 3 activities		36
Students with summer science-math lab jobs	17	
Number of different students in above activities		41

The main direct result of the summer on non-school activities showed in plans for employment the following summer. Seventeen planned work in science laboratories, and this number would be greater except for the government policy not to allow anyone under 18 to work on government sponsored research projects. Some of the science fair or club activities can be traced to the summer's influence, such as the students who continued their summer projects for contest entries.

A few other results of the summer program on outside activities were reported, such as one student who had subscribed to Scientific American, and another who viewed early morning television classes in chemistry and physics which he felt were better than those in his high school. One boy had been motivated to teach himself calculus, and four were spending considerable time following up their summer projects. Students were asked what limiting factors prevented them from spending more time with science activities. For many it was apparent that their course work simply left little extra time. Two indicated that working after school prevented it. However, it was generally found that students were interested in taking advantage of opportunities available to them in science and mathematics outside of course work.

Sharing of Summer Experience: The values which could be accrued from a sharing of students' summer experiences upon return to high school were not emphasized during the summer program. And although all students indicated they had discussed the summer with their friends, 30% had not talked about their experience with their current science teachers. (See Table XXII) About one-third had been invited to discuss the general program with a science class or with a class of juniors who might be contemplating entering the following summer. But there was only one example of specific use of new knowledge from the summer's study when one biology department made use of slides and a film which a student had heard about at Thayer. There was little evidence that the general community was receiving benefits from having a student participate, although nearly one-half had received newspaper publicity. One had spoken to a Rotary Club, and another had told about the program at a meeting of top science students from several schools.

Table XXII

Sharing of Student Summer Experience

Students discussing summer with other students	55
Students discussing summer with current teachers	38
Students sharing experience with community	2
Students receiving newspaper publicity	25

Student Criticisms and Suggestions for Summer Program: The students who studied at Thayer all seemed to sincerely appreciate having had the summer's opportunity. Only one did not indicate a wish to spend the next summer in a similar research environment; this exception was being sent to Europe to represent the community YMCA. There was no serious criticism of the program expressed, and to obtain any comment at all it was usually necessary to ask students to recommend changes, or to prompt them. The main consistent criticism was from ten who felt the Wednesday evening programs failed to meet everyone's interest each session. Table XXIII shows that 16 had miscellaneous suggestions for the curriculum of the orientation program, and 18 commented on aspects of their research laboratory experiences.

Table XXIII

Student Recommendations for Improving Program

Aspect of Program	Students Commenting
Curriculum of orientation program	16
Wednesday night program	10
Research laboratory experiences	18
Cost of program	8
Program too short	4
No comment	6

Students were asked specifically about possible future tuition charges. None felt they would be willing to pay more than $200, and only 14% would pay $100-$200. Twenty-five percent felt they would pay up to $100, and 61% recommended no tuition. Some volunteered that although they would not have paid at the beginning of the program, they would have been willing to pay at the end. All but two students favored provision for boarding at least some of the students during the two-week orientation program, if cost were not a factor.

Students were also consulted about what personality attributes and general qualifications they felt were most important for participants in the Thayer program to have. Table XXIV summarizes their comments.

Table XXIV

Attributes Important for Program Participation
(Student Estimates)

Attribute	No. mentioning (out of 55)
Interest (enthusiasm, initiative, high motivation)	38
Aptitude (general and/or specific)	20
Ability (intelligence)	16
Personality factors (get along with people, work with others)	12
High School marks	12
Work habits (open-mindedness, drive)	9
Willingness to work (persistence)	8
Maturity (attitudes)	6
Past achievements (projects, experience)	5
Teacher recommendations	4
Ability to write	2
Ability to express oneself orally	2
Career interest	1

Student Desires for Guidance: The spring interviews with the students revealed their definite desire for more information about colleges, college courses, scholarships, non-class science activities, scientific careers, etc. We even received telephone calls from parents requesting similar types of information.

In view of this apparent interest in increased guidance services, the Follow-up Questionnaire II mailed in June (Appendix page xxx) included a question which attempted to determine the extent of that interest. The question and results (based on 91% return) are as follows:

A regional science consultant or advisor might have provided information related to the following topics during this past school year. Place a check in front of those topics which you would have personally sought information:

Number Students checking item	
20	career information
23	selection of colleges
24	selection of college courses
33	scholarships and financial help
24	available science and math contests
27	part-time school jobs in science and math
41	summer jobs in science and math
16	sources of special equipment and supplies
25	sources of special reference sources and textbooks
30	listing of current speakers and events of science and math interest in the Boston area
13	suggestion for science club activities
17	suggestion for science fair projects

Volunteered items included:
What additional science courses are available during the year or summer school?
Are science advisors available to school?

The Teachers

The classroom teacher is of utmost importance in determining the extent to which an individual student will be able to pursue a challenging program. Encouraging a student who has been to a special program to build on the summer's work and experience, providing a challenge to talented students through special provisions, and helping guide a potential scientist in his college and career plants -- these would all seem to be possible services the classroom teacher could perform. This turned out to be an idealistic hope not realized.

Knowledge of Summer Program: It has been previously pointed out that 30% of the summer students did not discuss the summer program with their present teachers. (Table XXII) It was further discovered in the teacher interviews that, excluding the teachers at Thayer Academy, less than ten of the fifty-two teachers interviewed gave evidence of having any considerable familiarity with the students' summer experience. A few had asked to read the final report of a student's summer project, and some had invited students to discuss the program in class. It is suspected that if these teachers had some communication from Thayer Academy about the program, a greater number would have inquired about the students' experiences there.

Since few teachers were sufficiently informed of the program to capitalize on its benefits, there was little reason to expect that any special effort had been made to incorporate the student's experiences into the school's program or to make special provisions for him to carry oh work similar in nature to that done during the summer. However, enough good results have occurrred with a handful of teachers who did make an effort to follow-up the summer's experiences to suggest that concentration of these different efforts would result in a considerably more challenging school year.

Special Provisions: In general, teachers and other school personnel recognize the intellectual capabilities of the talented students, but are often at a loss as to how to proceed with plans for challenging them. One teacher, for instance, thought that she was doing her talented student a favor by excusing him from doing any homework as long as he continued to get an A in class. Table XXV shows that few special provisions for top science students were reported. Several teachers indicated that they had given a student a college text for reference. Three students were employed by the school system as laboratory assistants. Four others had received permission to use the laboratory during free periods during the day or after school. Arrangements had been made for one student to audit lectures in a math course where it was felt his course work was too full to carry the additional course for credit. Three students had occasion during the year to teach a science class for a full period. In one situation where the double sessions of the school afforded little change for after school work on a science fair project, a student was given permission to take school equipment home to use. Although some teachers appeared uncertain whether they can legally allow students to borrow such equipment, or even to work alone in a science laboratory without the teacher being present, others felt it to be a desirable practice with talented students and are doing it.

In a few instances, attempts had been made to provide instruction beyond the normal course offering. One teacher was privately tutoring a student in calculus after school without charge. Another student was allowed to work with two others in an "advanced chemistry class", although little teacher guidance was provided for this and some of the time was used to prepare chemical and apparatus which the teacher would use for other classes. One of the Thayer teachers who had taught in the summer program arranged for two of his summer students to attend occasional lectures at Harvard University. These instances constitute the extent to which any special provisions appeared to have been made for these students.

Table XXV

Special Provisions for Students

	% of students provided
One or more provisions*	22%
No special provision	78%

*This does not include advanced courses, or chance to discuss summer program with class.

Interest in Student College and Career Plans: Only about three students indicated that teachers during the year had played a major role in influencing their college and/or career plans. About two-thirds of the teachers had some knowledge of where the student was applying to college, and some had written college references. Less than half had any knowledge of what careers the student was considering, and less than 25% could be considered involved in active career guidance of students. A good number of these teachers indicated that their guidance department handled such matters, and suggested that this was not a responsibility of the classroom teacher. One case is known where a teacher had been directly involved in helping a student find summer employment.

Teacher Criticism and Suggestions for Program: The general reaction of the teachers to questions about the summer program indicated high favor with the present set-up. They were impressed with the high caliber of the students in the program, several commenting that when they recommended several students, Thayer always seemed to pick out the very best to participate. Many teachers expressed the wish that they, too, could have had a similar experience.

The teachers seemed to feel that the program had certain intangible benefits to their classes as a whole, resulting from the transfer of the participants' new seriousness of purpose, work habits, enthusiasm, etc. to the other students. However, they indicated that the main value was to the individual participant and the use of returning students for the general improvement of the science and mathematics education of others ought not to be a criterion of success by which the summer's program should be measured.

All the teachers approved timing the study to reach students after their junior year, agreeing that this made the experience an important guidance tool in helping students select colleges and courses in terms of more realistic career knowledge. However, some teachers expressed the possible desirability of allowing exceptions to the practice of taking only high school juniors.

No teacher thought that the Thayer program had duplicated course content to the extent that it inhibited student interest in senior year courses.

Because few teachers were familiar with the details of the program, it was not surprising that few offered suggestions for its improvement. Several did express a desire to have had some communications with the director or supervisors of the program at its close which would briefly describe the experiences there. For some teachers the accomplishments of these students constitute one of their major satisfactions. Also, if public recognition of the student's acceptance in the program could include indirect or direct reference to the teachers partly being responsible, such action could help to encourage many classroom teachers.

Two or three teachers questioned whether students who sought to specialize in the area of mathematics would have the opportunity to engage in pure mathematical research, expressing concern that exposure to the more applied areas of mathematics might be giving a narrow view of the total field. But the same number of teachers were equally vehement that the opportunity to view the applications of mathematics were more realistic and desirable. Thus the discussion pointed out a certain schism on this issue. It was generally agreed, however, that another year of senior high school mathematics was not likely to enable the student to be much more capable of attacking basic research in the field. No further suggestions or criticisms were made by the teachers.

The Parents

Late in the following spring, the parents of the participants were asked by questionnaire (see Appendix) to indicate their general reaction to the program. Responses revealed these parents to have a sincere interest in, and concern for, the development of improved science and math education for secondary school students. The following results are based upon replies received from 50 (91%) of the parents.

Program Benefits: Parents were asked what they had considered to be the most important benefits of such a summer's experience for high school students. The wide variety of responses are summarized in Table XXVI. According to the parents, by far the most important benefit was the personal association which students had had with scientists and with fellow students having similar interests and abilities. Other benefits concerning careers, research experience, and pre-collegiate instruction were similar to responses made by students and teachers during the time of the interviews. The following excerpt is characteristic of responses to this question: "(She had) the opportunity to work with other students of similar interests, and particularly of similar intensity, in an atmosphere where such seriousness of purpose is not strange. . .She was particularly interested in seeing what day-by-day work was like, in meeting professionals and technicians in the field, and in broadening her view of biology into the field of biochemistry . . . It certainly does the young no harm to realize that along with their ambitious notions of what they will accomplish in the world of science (especially romanticized these days) they will have to do a great deal of repetitive and unexciting drudgery."

Evidences of Change in Students: In reply to the question which asked parents to list evidences of change in their son's or daughter's interests or activities which may have been attributed to the program, a smaller number of responses were illicited. (See Table XXVII) Eleven parents indicated no change having taken place. For many students there was a strengthening, intensification, and crystallization of previous interests. There was no evidence of "negative" changes having resulted. Although not typical, the following is evidence of change which may result: "His specific interest changed from mathematics to physics; his approach from technical to liberal arts; and his possible goal broadened to perhaps include teaching."

Family Sacrifices: The major provisions or personal sacrifices made by parents in order to make it possible for their child to participate in this program consisted of providing for transportation and adjusting family vacation plans. Several students would otherwise have been employed and contributed to the family's income. In no case was there an indication that such impositions had caused the parent to feel that the child had not spent a worthwhile and valuable summer.

Recommendations: As all parents indicated that the summer had been worthwhile for their child, the recommendations which were made by the parents were not of major proportions. (See Table XXVIII) The most frequently occurring recommendation concerned the providing of an expended program to allow more students to benefit from similar experiences. Industry was encouraged to take an increased role on this behalf. Increased publicity about the program was urged. No parent suggested that tuition rates be charged of students and several hoped that there could be increased scholarship aid and even stipends provided students. Other parents suggested ways in which concurrent and follow-up guidance would have been beneficial. One commented, "We believe that it would be helpful for the student to have an opportunity to participate in planned placdment each summer throughout the college training period, so there would be a design and plan in correlation with the college program."

Reservations about the program were held in two cases. One said, "It is our feeling that (our son) would have benefited more from a summer spent entirely at Thayer, rather than divided between Thayer and Industry. Much of his 'industry time' was routine and unchallenging and not wholly rewarding, although his personal associations were friendly. We feel that high school students may be unready for so-called research experience." This observation takes exception to the many parents who indicated the benefits to students accruing from research experience in the laboratories and with the opportunity to personally associate with research scientists.

Another parent concludes: "I feel that if the main purpose of this program is to interest more young people in science to help our national scientific personnel problems, then it is a failure. This is so because the rigid examinations and selection that is practiced results in only those who are already well interested in science winning a place in the program." Although the purpose suggested was not a primary objective of this program, different screening techniques would be required for achieving such an objective.

One of two parents to have had children in both of the Thayer programs during the last two years makes the thoughtful conclusion: "I think the subjective atmosphere in the placement (of students in research laboratories) is very important, and can make or break its value, irrespective of the nature of the work itself. Where morale is good, the staff cohesive and stable, and where there is at least one person who will take special pains with a young student, a laboratory which is not really pioneering can be very stimulating; but without those qualities, even the front-lines of science can fail to touch a young person who is there, after all, only for a short while and not prepared either in education or maturity to make the atmosphere contribute to his own needs." We agree.

Table XXVI

Program Benefits Reported by Parents

	Number Parents Reporting (N = 48)	
Student Betterment		26
Association with other students	16	
Maturing and self evaluation	4	
Motivation	3	
Self-confidence	3	
Career Benefits		21
Working with scientists	12	
Career implications	2	
Practical experience	4	
Crystallization of career interests	2	
Stimulated interests	1	
Academic Benefits		39
Pre-collegiate courses	7	
Deeper content	6	
Research methods	9	
Study habits	1	
Exposure to top rate educators	1	
Practical application to knowledge	2	
Independent thinking	1	
Aspires for higher achievement	1	
Oral expression	1	
New horizons	1	
Writing thesis	2	
Preparation for college	2	

Table XXVII

Evidence of Change Reported by Parents

	Number Parents Reporting
Interests (heightened, intensified, crystallized, strengthened)	21
Career Changes	8
College Changes	5
Improved Study Habits	7
Summer Plans Changed	4
Miscelleaneous	3
No Change Reported	11
	59

Table XXVIII

Parent Recommendations

Area of Recommendation		Number of Parents Reporting
Organization of Thayer Program		1
Administration of Thayer Program		19
Board and room	4	
Better publicity	3	
Guidance counseling	6	
Increase scholarships & stipends	4	
Decrease length	1	
Accept sophomores	1	
Expand program for more students		9
Better placement in labs		2
Involve more industries		5
Expand curriculum to include non-science courses		1
		37

Chapter V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The most important finding of this investigation is that standardized instruments are finally becoming available for science education research which can detect changes in student behavior in areas other than mastery of the facts and principles of science, and can detect these changes over relatively short periods of time. Such instruments are especially important for evaluating summer science programs, since "coverage" of a particular body of content is sometimes not a major objective, and evaluations must be in terms of operationally defined objectives. Also, the summer program is usually only six or eight weeks in length (seldom more than ten weeks) and such intervals were thought to be too short for statistical evaluations of the type attempted here.

We do not pretend that the results and conclusions of this investigation are generalizable to all special summer science programs. The major effort has been directed toward furthering the development of methodology in science education research which might eventually result in a sounder basis for decision making. In this respect we might claim some success. In addition to the development of procedures for effectively executing summer science program evaluations, some specific conclusions and recommendations regarding the Thayer program are possible. This chapter will consider those findings reported above which seem the most significant.

The Ten-Week Program

The question of primary concern probably is: Did the Thayer Program accomplish what it set out to accomplish? Certainly what was done during the ten-weeks adhered closely to the description in their proposal to the National Science Foundation. This in itself seems fairly unique in view of the frequent disparity between program operation and program proposal. However, the more important question is whether or not changes in student behavior resulted.

The major changes which were observed during the ten-week period involved the student's image of science and scientists, and student plans for college and career. These of course are highly interrelated and are expected results of a program in which student exposure to scientists in action is the primary activity. Therefore, as a career guidance device, the program was highly successful. It gave the students a close look at scientific research, both the menial tasks and the thrill of discovery. They are now in a better position to decide "is science for me?". Also, the timing of this type of program seemed highly appropriate. Coming at the end of eleventh grade, the students are in a better position to make those decisions required of them during the final year in high school.

The trends in their image of science and scientists were, in general, toward increased realism. The distinction between science and technology became clearer, and the scientist became less awesome. The changes in choice of college were toward more liberal arts. The career plans shifted in the direction of increased interest in scientific research and included a new awareness that college teaching was a career in which research was possible.

In terms of increased compêtence in science and mathematics, the students did change in abilities measured by the STEP Science test which included screening hypotheses, interpreting data, and quantitative reasoning. However, no change was observed in performance on the STEP Mathematics test. There are several reasons for this finding. One is the lack of emphasis on mathematics for all students. Also, after the program was underway we realized that the mathematical experienfes offered these students were not consistent with the emphasis in the STEP test. This illustrates two general difficulties: 1) a ten-week program can't be a "cure-all" and shouldn't try to be; 2) evaluative instruments cannot be effectively chosen if objectives are not clearly defined or practices are inconsistent with the objectives of the program. Both factors may have operated in the case of the STEP Mathematics finding.

Of the various aspects of the program (two weeks of classes and lab, evening lecture series, eight-week research experience), the students considered the research experience as the most valuable and the evening programs as probably the weakest. A greater effort to "tie-together" the evening lectures and seminars might help the student see their value. This was especially true of the Wednesday evening sessions held during the final eight weeks.

The success of a program of individual student research is greatly dependent upon the process of selecting the right students. In selecting students for this program, the staff faced somewhat of a dilema. Because the students are expected to work in unfamiliar surroundings with unknown adults, conforming, extroverted, personable students would present fewer personnel problems. However, giving preference to those students may be by-passing some students who would make good research scientists. Of course similar problems are faced by any attempt to single out "future scientists" for preferred treatment or encouragement through scholarships and honors. Until valid predictors for choice of and success in scientific research are available, the reasonable approach seems to be to select the most able students from among the applicants, using several measures of scholastic aptitude and achievement, and let them "try out" science. In this way the future scientists in the group are aided by the experience, and their able peers who go on into other fields will have a better understanding of science and scientists, certainly desirable outcomes.

Realizing that this is the case, it is important in publicizing such programs to insist that they are for able students, and not give the impression that all those selected are future scientists (chosen with certain divine powers) and that those rejected do not look like future scientists. Both impressions are unfortunate and they tend to be conveyed in published descriptions of the programs, if not explicitly, certainly implicitly.

Unfortunately, this investigation was unable to uncover valid predictors of rated student success, so confident suggestions for more efficient screening instruments are not possible. Measures of scholastic aptitude and achievement in science and mathematics, together with an interview or questionnaire concerning the extent to which students have voluntarily engaged in home laboratory "research" and extra-class science activities, seem to be the most reasonable approach to selection until improved techniques are devised.

Back to School Follow-up

In our follow-up observations we were forced to rely on the statements of students, teachers and parents, since pre-post measures of the changes in school behavior resulting from the program were impossible in this investigation. In addition to these stated opinions, the special provisions (curricular, extra-curricular, guidance, etc.) for these students that were available in the regular high school were observed. Also, parents, teachers and students made recommendations regarding the program which were worth considering. These were the main concerns of the follow-up questionnaire and interview.

As far as student changes in school behavior are concerned, improved study habits and greater seriousness of purpose were most frequently reported. The parents and teachers reported no negative effects, but students felt a lack of challenge in the school work and several reported they were bored. That, of course, may not be a result of their previous summer so much as their exposure to a school curriculum designed for less able students. (Procrustes again!)

The non-class science activities did offer some opportunity for individual enrichment, but this was too often left to chance and at times was even impossible. The demands upon the science teacher are too great to allow time for him to give serious attention to these highly able students. This was also reflected in the college and career guidance offered these students. The one-man guidance department in a school of 1000 students is rather inadequate, and the science teacher either cannot or will not perform guidance functions for students interested in scientific careers. Yet the students hunger for additional information about college programs, possible scholarships, future summer science employment, and possible careers. Regardless of where the responsibility lies, the summer programs might seek ways to offer students more guidance information. At Thayer, for instance, a few of the evening sessions might have been devoted to general problems of college admissions, different types of colleges and technical schools, scholarship aid available, etc. Bringing in some college admissions people would be helpful for such sessions. The students were ably shown what scientists do, but more time could well be spent on how to get there.

The follow-up reactions of students, teachers and parents indicated an overwhelming vote of confidence for the program as it exists. However, a few criticisms were voiced. The most frequent recommendation was for improved communication. Before, during and after the program this seemed to be a major difficulty. Parents and teachers would have liked to know more about the program, how their son or student did, etc. Parents and school personnel were extended invitations to attend the final day symposium, where student papers were read, but many could not take advantage of this opportunity. No direct attempt was made to contact the science and mathematics teachers following the summer program. The scientists also wished for more information before the students arrived for laboratory work. Determining who is interested, what they want and need to know, and how to communicate this to them is indeed a difficult problem. But the "back to school" situation would be highly improved and the program would have much greater and broader impact if this communication problem could be solved.

Comparisons With Peer Groups

The fact that the Thayer praticipants could be compared to college bound students of the same age group and geographic region who are subjects of the Scientific Careers Study was advantageous to both investigations. The science: non-science trends in interest, temperament and certain questionnaire responses observed in the SCS, illustrating the operation of personality determinants in the movement toward scientific careers, were cross-validated by the Thayer results. Further follow-up of these students will reveal what confidence we can have in these findings.

One important relationship evident in the SCS comparisons is the high socio-economic status of the families of the summer program participants. This tendency was also observed by an other investigation of these programs.[1]

---

[1] Science Research Associates. op cit., page 19.

The obvious reason is that less fortunate students must have some summer income if they expect to go on to college. Some scholarships were awarded at the end of the program to deserving students, but this seemed insufficient to attract students of lower income families. The science teachers interviewed seemed to feel that a stipend of one or two hundred dollars would have made possible the participation of many able students who otherwise exclude themselves because of financial need. The problem of whether such stipends can and should be made available depending on need, and how to determine that need, is not easily solved. Our feeling is that it would represent a small increment to the current cost of such programs, and talented students (even from homes of lower socio-economic status!) are resources too valuable to disregard in any society. Such a stipend or "scholarship" might be made available by the laboratory in which the student works, especially the industrial laboratories. Other organizations, like local PTA's or scientific societies might be able to make small sums available to favorite sons.

Further Research

Two related research efforts have already emerged from this investigation. The results of the summer testing indicated the promise of the Facts About Science test. But an improved instrument seemed necessary. We are therefore developing here at the Harvard Graduate School of Education a new instrument, the Test on Understanding Science, which will attempt to measure student perceptions of science and scientists. This test will receive a nationwide try-out during the 1960-1961 school year as part of a research project investigating the utility of history of science cases in high schools (U.S. Office of Education Cooperative Research Project Number 896.).

The other research activity stimulated by this investigation is an exploration of the role and utilization of a consultant who would serve as laison man between summer programs and schools, and between students and future opportunities. The problem is to see whether or not it is possible to close somewhat the communication and guidance gap noted above, and if possible, to determine what differences such services make in the "follow-through" impact of the programs.

Future investigations will certainly need to be concerned with the relative merits of various approaches to summer program design. This does not imply that attempts should be made to arrive at the one best procedure for conducting these programs. This would be undesirable even if it were possible, but people still keep talking that way. However, comparisons in terms of several criteria of student change (such as those used or developed in this investigation) would indentify those methods which tend to produce greater change in particular types of behavior. Then if the program designers know what changes are to be emphasized, evidence will be available for deciding on procedural emphasis.

Our own position is that the Thayer program did a creditable job, both in deciding whihh objectives were important to emphasize and in devising procedures for accomplishing their purposes. The Thayer approach can be highly recommended to programs held in areas where ample research opportunities are available. If the primary intent is to unload more science facts and principles, then other procedures would be more suitable. However, such an objective is inconsistent with the stated purposes of the National Science Foundation programs, which suggest that these programs provide experiences not normally available in the high school, and current high school science programs are strong on facts and principles.

In view of the major research evaluations being conducted for the National Science Foundation during the summer of 1960, it would not be reasonable for us to make elaborate detailed suggestions for further research at this time. When the results of those current evaluations are available, investigators interested in inquiring further into the consequences of this new educational innovation will be able to build on those more recent efforts, in addition to the findings reported herein. Other discussions of summer programs, evaluations and plans for research, can be found in the references listed on the following page.

BIBLIOGRAPHY

Bliss, Horace H. "Experiences with 100 High-Ability Science Students in a Six Weeks College Level Study Program". Paper delivered before Section Q, American Association for the Advancement of Science, Chicago, December 29, 1959.

Chatfield, A.S. "Summer Science Camp at Community Junior Colleges", Junior College Journal. (April, 1959) 29: 478-480.

Cotton, William and Moyer, June. "SUNYTC Genesco Proves that Gifted Children Like Science at Special Summer Class at College", New York State Education. (November, 1958) 46: 94-96.

Durst, L.K. "The Rice Institute Summer Program for Talented High School Students", National Association of Secondary School Principals Bulletin. (May, 1959) 43: 74-76.

Edmondson, Don E. "JvN Memorial Mathematics Summer Seminar For Talented High School Students", Natl. Assn. Sec. Sch. Prin. Bulletin. (May, 1959) 43: 77-78.

Educational Research Service. "Summer School Programs in Urban School Districts", Circular No. 7, 1959. (October, 1959) 41 pages.

Fullerton, Garry. "Summer-School Science and Mathematics", National Education Association Journal. (April, 1960) 49: 35-36.

Klinge, P.E. "University Summer Programs for Gifted Science Students", Indiana University School of Education Bulletin. (March, 1960) 36: 1-52.

Montague, Harriet F. "A Demonstration Class in a National Science Foundation Summer Institute", Natl. Assn. Sec. Sch. Prin. Bulletin. (May, 1959) 43: 98-100.

National Science Teachers Association. New Developments in High School Science Teaching. Washington, D.C., 1960, pp. 7-20.

Nichols, Eugene D. "A Summer Mathematics Camp for Talented High School Students", Natl. Assn. Sec. Sch. Prin. Bulletin. (May, 1959) 43: 100-103.

Pettit, Lincoln. "A Summer Science Camp", Science Education. (March, 1960) 44: 134-138.

Quensel, Raymond A. "An Experiment in Staff Utilization with Talented Students in a Small High School During the Summer Months at Newark, Illinois", Natl. Assn. Sec. Sch. Prin.. Bulletin. (January, 1960) 44: 49-55.

Richardson, Bellows, Henry and Co., Inc. "A Look at the 1959 National Science Foundation's 'Summer Science Training Program for High-Ability Secondary School Students'". Report prepared for the NSF, December, 1959, 207 pages.

Schenberg, Samuel. "Summer Employment of Ssience Students in Industry and Research Laboratories", High Points. (March, 1958) 40: 33-42.

Science Research Associates. "Evaluation of the 1959 NSF Summer Science Training Program for Secondary School Students: Report No 2. Contract NSF - C115". Chicago, Illinois, February, 1960. Mimeographed.

PROGRAM STAFF

Gordon O. Thayer, A.B., Ed.M., Ed.D., Headmaster, Thayer Academy
Director, Advance Studies in Science

William Stergios, B.S., M.S., Administrative Assistant,
Head, Science Department

Maurice Seymour, B.S., Ed.M., Head, Mathematics Department

Kenneth Jones, B.S., M.S., Master, Science Department

Vinson Bronson, B.A., B.S., Master, Science and Mathematics Departments

Visiting Instructors

Edward Booth, Ph.D., Boston University, Physics Department

Albert Olsen, Ph.D., Brandeis University, Biology Department

Robert Stolow, Ph.D., Tufts University, Chemistry Department

PARTICIPATING LABORATORIES

UNIVERSITIES

Boston University
Brandeis University
Brown University
Harvard University
Massachusetts Institute of Technology
Tufts University
University of Massachusetts

HOSPITALS

Children's Medical Center

INDUSTRIES

American Optical Company
Armstrong Cork Company
AVCO Research Laboratory
S.H. Couch Company, Inc.
The CRYOVAC Company
Electro-Switch Corporation
Fabric Research Laboratories, Inc.
ITEK Corporation
Arthur D. Little, Inc.
Polaroid Corporation
Radio Corporation of America
Raytheon Manufacturing Company
Sylvania Electric Products, Inc.
United Shoe Machinery Corporation
Walworth Company

COURSES OF STUDY: TWO-WEEK INSTITUTE

BIOLOGY

Unit I: The Chemical Constituents of the Cell.
- A. The Elements: Unusual Properties
- B. The Compounds
    1. Water
    2. Amino acids
    3. Peptide hormones
    4. Proteins
    5. Nucleic acids
    6. Residual proteins
    7. Enzymes
    8. Carbohydrates
    9. Fats

Unit II: The Structure of the Cell and Problems in Research.
- A. Cytological Methods
- B. Problems in Cytological Procedures
- C. Morphology of the Cell
    1. General considerations
    2. Cell membrane
        - a. Hypothesis of Danielli
        - b. Chemical character
        - c. Permeability properties vs. enzyme film
    3. Ground substance or hyaloplasm
    4. Cellular inclusions
    5. Nucleus and its membrane
    6. Chromosomes

Unit III: Activities of the Cell.
- A. Cell Division and Embryology
- B. Cell Diffusion Phenomena
- C. Cell Metabolism: Role of ATP-ase in Oxidative Phenomena

Unit IV: Seminar on Research Problems in Pathobiology.
Areas to be chosen by individual students for presentation and discussion.

LABORATORY TECHNIQUES IN BIOLOGY
List of Experiments:
1. Nature of Membranes
2. Osmotic Behavior and Selective Permeability of the Cell Membrane.
3. Dialysis
4. Enzyme Transfer
5. Reaction Rate vs. Substrate Concentration in Cells

CHEMISTRY

FOR THE CHEMISTRY DIVISION
Physical Methods of Structure Deterioration
1. Infra-red Spectrophotometry
2. Paper Chromatography
3. Ion Exchange Chromatography
4. Nuclear Magnetic Resonance

CHEMISTRY - cont'd.

FOR THE OTHER DIVISIONS (Biology, Mathematics, Physics)

1. Chemical Equilibrium
2. pH and Method of Measurement
3. Proteins, Carbohydrates, and Lipids
4. Pathways of Biochemical Synthesis in Cells
5. Pathways of Photosynthesis

LABORATORY TECHNIQUES IN CHEMISTRY

Each student chose one experiment (specially compiled) to complete in the two-week period. The list of experiments follows:

1. The Estimation of Iodine in Seaweeds
2. The Preparation of Boron
3. The Isolation of Radioactive Isotopes from Fallout
4. The Determination of the Quantum Efficiency of a Photochemical Reaction
5. The Synthesis of a Plant Growth Stimulant
6. The Synthesis of Two Indicators, Methyl Orange and Phenolphthalein
7. The Extraction of Caffeine from Tea
8. The Separation of Ni^{++} and Co^{++} by Means of Ion Exchange
9. The Preparation of Some Polymers
10. The Qualitative Analysis of an Unknown Substance
11. The Quantitative Analysis of Limestone
12. The Synthesis of Indigo

PHYSICS

I - Students with Physics as major interest: The course's intents was to introduce to the students the terminology and principles usually given in a college freshman course.

- A. Scalers and Vectors
  1. Static and equilibrium
  2. Velocity and acceleration
  3. Newton's Laws
  4. Angular momentum
  5. Work and energy
- B. Wave Motion
  1. Light, nature of
  2. Optics
  3. Interference
- C. Coulomb's Law
  1. Potential
  2. Capacity
  3. Ohm's Law
- D. Atomic Physics

II - Students with major interest other than Physics: This course attempted to find a balance between principles and the philosophy of the experimental sciences.

The vehicles for accomplishing this purpose were Case 4, The Atomic and Molecular Theory, "Harvard Case Histories in Experimental Science", by Leonard K. Nash, and selected problems going more deeply into such concepts as density, pressure, specific gravity, and Boyle's Law.

PHYSICS - cont'd.

EXPERIMENTAL TECHNIQUES IN PHYSICS

List of experiments:

1. Determination of "e" - Millikan Oil Drop
2. Measuring e/m
3. Determining "h" - Plank's Constant
4. Spectral Analysis
5. Gamma Ray Counting

MATHEMATICS

Part I: Calculus

A. Differential
   1. Slopes of curves
   2. Inflection points
   3. Velocity and acceleration
   4. Rates of change
   5. Maxima and Minima
   6. Tangents and Normals
   7. Vectors and Force Components
   8. Applications to Analytical Geometry

B. Integral
   1. Areas under curves
   2. Volumes of Revolution
   3. Volumes of Solid Figures
   4. Projectiles
   5. Pressures and Densities
   6. Center of Gravity

Part II: Algebra - Trigonometry - Analysis

1. Variation
2. Radians - machines - angular velocity
3. Triangulation - vectors
4. Spherical application
5. Conic Sections
6. Sound and light waves

Part III: Combinations - Permutations - Probability Binaries

Part IV: Statics

1. Bodies in equilibrium
2. Tensions
3. Vector forces

Part V: Statistics

Problems dealing with:

1. Variation
2. Frequency
3. Normal curve
4. Standard deviation
5. Means and medians

EVENING LECTURE SERIES

Dr. Frank C. Benner
National Research Corporation
Topic: "Gases in Metals. Their Significance and Analysis".

Dr. Richard S. Manly
Tufts Dental School
Topic: "Research on Dental Caries".

Dr. William Montagna
Brown University
Topic: "General Considerations of the Biology of Skin".

Dr. Gordon Walker
American Optical Company
Topic: "Recent Developments in Applied Mathematics".

Dr. John R. Bergen
Worcester Foundation for Experimental Biology
Topic: "Brain Mechanisms and Behavior".

Dr. Irwin W. Sizer
Massachusetts Institute of Technology
Title: "Molecular Biology and Medicine".

Dr. Eugene C. Gasiorkiewicz
University of Massachusetts
Topic: "Research in Plant Pathology as Related to Industry".

Dr. James C. Andrews
University of North Carolina
Title: "Biological Compounds of Sulfur, Their Chemistry and Metabolism".

Dr. Sanborn C. Brown
Massachusetts Institute of Technology
Topic: "Science Versus Technology".

Dr. Fletcher Watson
Harvard University
Topic: "Observations in Science Education".

Dr. M. Kent Wilson
Tufts University
Topic: "New Concepts in Science".

Mr. John Hanson
National Research Corporation
Topic: "Putting Research on Paper".

Miss Jean Sammet
Sylvania Electric Products, Inc.
Title: "Mathematicians in Industry".

Dr. Donald Patt
Boston University
Topic: "Use of Hamster Cheek Pouch in Biological Research".

Dr. Mary-Ellen Jones
Brandeis University
Topic: "Chemistry and Metabolism of 'Energy-Rich' Compounds".

(Panel of Three)
Dr. Albert Navez
Newton High School
Mr. Gardner Handy
Winchester High School
Miss Anna Holman
Mass. Dept. of Univ. Extension
Title: "Accelerated Science Programs in Secondary Education".

STUDENT RESEARCH TOPICS

CHEMISTRY

The Synthesis and Investigation of CH_3OPCl_2 and CH_3OPF_2
Direct Synthesis of Silicon Compounds
In Vitro Metabolism of Mescaline
The Relationship Between the Chemical Structure and Biological Activity of Nicotine and Its Congeners
Formaldehyde Tanning of Collagen
Determination of the Degree of Homogeneity of Color Developed in Rubber and Thermosetting Plastic Flooring Compositions
Infrared Analysis of Plasticizer Content in Saran Systems
The Synthesis of Tetrazines
Synthesis of Certain Organo-Metallic Compounds
The Calculation of a Difference Map for the X-ray Structure of Trimethylphosphinoborane
Volume Photoconductivity Measurements of Luminescent Solids Using an AC Impedance Technique
Synthesis and Infrared Investigation of 1, 4-ditertiary butyl -- 1, 4-cyclohexane diol
The Measurement of the Thermal and Radiation Sensitivity of Rubber and Thermosetting Plastic Flooring Compositions
The Decomposition of Benzoyl Peroxide in Solid Polymers

BIOLOGY

The Effects of Liver Regeneration and Tumor Growth on the Rate of Turnover of Phospholipids, R.N.A., D.N.A. and Proteins in Subcellular Fractions
Paper Chromatography of the Embryonic Cells and the Tissue Culture in the Chinese Hamster
Photo-sensitivity of N-Methyl Thionicotinamide
The Isolation of the Various Thiamine Activities Found in Escharichia coli
The Effect of Cortisone on a Bacterial Pyrogen in Irradiated Mice
The Effects of Thrombus Formation on the Blood Vessel Wall as Observed in the Cheek Pouch of the Golden Hamster
Properties of Nerve Cells Transmitting Touch and Pain
Fat Synthesis - Its Site of Occurence and Physiological Control
The Identification of Iron in the Human Apocrine Sweat Glands by Use of the Electron Microscope
Purification of Hydroxy Enzymes in the Kidney of the Hog
Studies of Factors Involved in Reticulocyte Maturation
The Chromatography and Fluorometric Measurement of the Distribution and Excretion of MTX in Mice and Hamsters
The Preparation and Bioassay of Hypothalamic Extracts Capable of Stimulating ACTH Secretion in Vivo
The Effects of Certain Chemicals on, and Attempts at, Segregation in the Ascomycete, Neurospora crassa
The Influence of Nutrition upon the Development of Fusarium and Bacterial Wilt of Carnations

MATHEMATICS

Maximum Length Sequences of Digits with Pseudo-Random Properties
Trapezoidal Integration Through the I.B.M. 650 Data Processing System
Determination of Spectral Emittances
Matrix Cryptography
Pulse Discrimination, Diode Testing, Blackjack Probability Machine
Programming and Computing on the I.B.M. 650
Determination of Spectral Emissivities
Mathematical Models
Phase Velocity of Dielectric Waveguide Propagation in the 1 - 0 Mode
A Report on Research Assistance

PHYSICS

Basic Operation Theory of Diodes and Transistors
Physical Tests for the Evaluation of Epoxy Resins
Measurement of Sky Brightness and Star Scintillation
Research Methods Used in the Testing of Optical Lens Systems
High-Speed Switching Circuits Using Mesa Transistors
Non-Electrical Means of Amplification
Phase Meter - 3 Kilocylces to 3 Megacycles
Opening Techniques and Applications of the Omegatron Mass Spectrometer
Contact Resistance of 4-Pole Rotary Relays in Controlled Atmospheres
Preparation and Calibration of a Photoelastic Stress Model
Tests on Balancing the Characteristics of INZI Crystal Diodes
Regulated D.C. Power Supply for Use in Developing and Testing Magnetic Memory Units
Product Qualification of the MA - 12 Miniature Rotary Switch
Determining a Method for Measuring the Phase Difference in Scanned Antenna Arrays
Electrokinetic Phenomena in Flow Through Fabrics
Characteristics of Ferrite Aperture Plates

FINANCIAL REPORT OF PROGRAM

INCOME			
Foundation Grants:			
National Science Foundation Grant to the American Academy of Arts and Sciences		$33,570.00	
Ford Foundation - Fund for the Advancement of Education		10,000.00	
Total Income			$43,570.00
EXPENDITURES:			
From National Science Foundation Grant:			
Operational Expenses:			
Administration and Staff Salaries	$13,725.00		
Organizational, Supplies and Equipment	7,796.00		
Participant Support:			
Travel	4,379.00		
Meals and Insurance	4,326.00		
Indirect Costs:			
American Academy of Arts and Sciences	1,500.00		
Thayer Academy	1,700.00		
		$33,426.00	
From Fund for the Advancement of Education:			
Library Books, Supplies and Laboratory Equipment	$ 3,400.00		
Scholarships to Colleges	3,600.00		
		7,000.00	
Total Expenditures			$40,426.00
CASH BALANCE:			
National Science Foundation		$ 144.00	
Ford Foundation - Fund for the Advancement of Education		3,000.00	
Total Cash Balance			$ 3,144.00

Thayer Summer Program (1958)
Follow-up Questionnaire June 1959

Name ____________________

Home address ____________________

____

Now that a "cooling off" period has elapsed since your summer at the Thayer Advance Study Program in Science and Mathematics, we would like to get a few reactions from you about the ways in which last summer's experience may have affected you during this past school year. The questions which follow are not necessarily concerned with specific objectives of the summer program, but may be a by-product. The purpose of these questions is to determine some of the possible consequences of attending a summer program such as Thayer's. We are not trying to find out whether the program was "good" or "bad", we only want to know what happened next; so please be frank! Your responses will be held in strict confidence.

Since most of you were high school seniors this school year, the questions are primarily designed for that group. However, most questions can be answered regardless of your year in school. All questions refer to this past academic year or to last summer's experience in the Thayer program. Use the backs of these sheets if you need more space.

Please return the questionnaire to the following address, where the results will be tabulated:

Dr. William W. Cooley
Harvard University
7 Kirkland Street
Cambridge 38, Mass.

x

1. Name and address of high school you attended ______________________________

____

2. Name of college you expect to attend ______________________________

3. Your present year in school (grade or class) ______________________________

4. What courses did you take this year? (Please indicate your grade average in each and whether it was 1 or 2 semesters)

	course	1 or 2 sem.	grade
a.			
b.			
c.			
d.			
e.			
f.			

5. Did you find that this year's science and mathematics course work was more interesting or less interesting as a result of last summer's experience? (Please explain in what ways.)

6. Did you continue to conduct an individual research project? (If so, was it related to your research work last summer or was it in a different area?)

7. Were your science and mathematics teachers aware of and familiar with your last summer's experience?

8. Were any attempts made by your teachers to have you share your last summer's experience with classmates? (In what ways?)

9. Did you participate in any advanced placement courses or other "honors" classes in science and mathematics? (explain)

10. Please describe any other ways in which last summer's experience may have affected your classwork in science and mathematics.

11. Have you been awarded any other academic honors this past school year?

12. Did you participate in any science competitions this year such as science fairs or the Science Talent Search? (Indicate any awards won and the nature of your project.)

13. Do you think last summer's experience may have affected your winning of any of those awards? (refers to both questions 11 and 12)

14. Did the contacts you made last summer help you in deciding about which college to attend? (Explain in what way, if it did.)

15. Did last summer's experience help you decide what field to concentrate in (major in) when you get to college? (if yes, explain how)

16. Did your last summer's experience change your ideas about the nature of the work of a scientist? (If yes, please try to describe the changes.)

17. **Did last summer's experience change your ideas about what scientists are like as people? (If yes, please try to describe the changes.)**

18. **What are your present vocational plans? (In addition to naming a possible occupation, please try to describe what sort of things you actually want to do on the job, what satisfactions you hope to seek from your job, regardless of the specific job title.)**

19. **Did last summer's experience change your vocational plans? (If it did, please describe the change. If no change occurred, please describe how long you have had your present vocational plans.)**

20. **Now that you have had a year of school work since the Thayer program, you may have some additional suggestions for improving the program which did not occur to you last August when we asked for suggestions.**

General Questionnaire

Directions: Read each question carefully, then circle the number on the answer sheet provided which best answers each question. For a few of the questions there are no numbers to circle. In such cases, write the proper answer in the blank provided on the answer sheet.

11. How many brothers do you have? (Circle the correct number.)

12. How many sisters do you have? (Circle the correct number.)

13. How many brothers and sisters do you have that are older than you? (Circle total number older.)

14. Is your father living?

1. yes
2. no

15. Whether or not he is living, what is (or was) your father's occupation? What does he do? Be as specific as you can. For example; operates a milling machine, repairs jewelry, sells dry goods to retail stores, etc. (Write your answer on the answer sheet.)

16. For what kind of business or organization does he (or did he) work? For example; electric power company, state government, retail store, construction company, etc. (Write your answer on the answer sheet.)

17. Does your mother have a paying job?

1. She works full time.
2. She works part-time.
3. She does not have a paying job.
4. She is not living.

18. With whom do you live?

1. father and mother
2. just father
3. just mother
4. father and step mother
5. mother and step father
6. grandparents or other relatives
7. guardians

19. How much formal education did your father have?

1. some grade school
2. finished grade school
3. some high school or trade school
4. finished high school or trade school
5. some college or technical school
6. finished technical school
7. finished college
8. attended graduate school or professional school after college
9. do not know

20. How much formal education did your mother have?

1. some grade school
2. finished grade school
3. some high school
4. finished high school
5. some technical training after high school
6. some college or finished junior college
7. finished college
8. attended graduate school or professional school after college
9. do not know

21. Where was your mother born?
   1. in the United States
   2. in Canada
   3. in the British Isles
   4. in Mexico or South America
   5. in Europe (example; Scandinavia, Germany, Austria, France, Italy, Spain)
   6. in Russia
   7. in other area

22. Where was your father born?
   1. in the United States
   2. in Canada
   3. in the British Isles
   4. in Mexico or South America
   5. in Europe (example; Scandinavia, Germany, Austria, France, Italy, Spain)
   6. in Russia
   7. in other area

23. Is your family in a particular religious group?
   1. no
   2. Protestant
   3. Catholic
   4. Jewish
   5. other

24. Do you belong to any school clubs?
   0. none
   1. one
   2. two
   3. three
   4. more than three

25. Are you an officer (chairman, etc.) in any of the school clubs of which you are a member?
   1. no 2. yes

26. Are you, or have you ever been, a class officer in this school or any other school?
   1. no 2. yes

27. Are you on any school or city athletic teams?
   1. no 2. yes

28. Are you a member of any organizations other than school clubs? (religious youth organizations, scouts, etc.)
   1. no 2. yes

29. Have you been an officer in non-school clubs?
   1. no 2. yes

(11th Grade Supplement)

30. Of the people your own age with whom you spend most of your free time, how many of them plan to go to college, or are already going to college?

1. none	3. most of them
2. only a few	4. all of them

31. What are the college plans of your best friend?
1. definitely planning to go to college, or is already in college.
2. thinking about college and will probably go
3. thinking about college, but will probably decide not to go
4. not planning to go to college
5. he doesn't know
6. I do not know his college plans.

32. To what extent have you discussed going to college with the teachers or guidance counselors (advisors) in your school?

1. not at all	3. more than twice
2. once or twice	

33. To what extent have you discussed going to college with your parents (or guardians)?

	2. once or twice
1. not at all	3. more than twice

34. Think of what you would really like to do when you finish high school. What statement in the following list tells what you would most like to do if you had your own choice?
1. go to college
2. work for a year or two and then go to college
3. get a part-time job and go to college
4. get a part-time job and go to college at night
5. go to a trade school, or take special training
6. get a job
7. become an apprentice
8. enter the armed services
9. other

35. What do you think you will do when you finish high school?
1. go to college
2. work for a year or two and then go to college
3. get a part-time job and go to college
4. get a part-time job and go to college at night
5. go to a trade school, or take special training
6. get a job
7. become an apprentice
8. enter the armed services
9. other

36 - 38. Why do you want to go to college? (You may circle more than one answer, but please blacken the circle for the one most important reason.)

00. I do not want to go to college
01. A college degree is necessary for the kind of work I want to do.
02. My parents insist upon my going to college.
03. I want the close fellowship of living in a dormitory or fraternity house.
04. College graduates earn more money.
05. I want to explore several lines of work to see what I am most interested in.
06. I enjoy studying and want to continue academic work.
07. There is not much for me to do around home.
08. My teachers urge me to go to college.
09. Business, church, or community leaders tell me I should go to college.
10. I want to get into college athletics.
11. It has always been expected that I would go to college.
12. I like the idea of being a college graduate.
13. Most of my friends are going to college.
14. College life will help me to develop socially.
15. It will be fun to go to college.
16. It will help me make good business contacts.
17. Other (specify on answer sheet.)

39 - 41. If you do not go to college, what will the reasons probably be? (Again please blacken the circle for the most important reason.)

01. A college education would not help me to do the things I am most interested in.
02. I want (or need) to start earning a living as soon as possible.
03. It would cost more than my family can afford.
04. I would rather get married.
05. My teachers think I should not go.
06. My high school grades are too low.
07. I am not sure I want to go.
08. I don't think I have the ability.
09. I would cost more than it is worth.
10. It is more work than it is worth.
11. My family does not want me to go.
12. Most people I know (my family and friends) do not go to college.
13. I have never thought about going to college.
14. I have never thought about why I might not go to college.
15. Other (Specify on answer sheet.)

42 - 43. If you do plan to go to college, what will you probably study? (Circle only one number.)

00. I have no plans and cannot say.
01. physical science (for example, physics, chemistry, geology)
02. pre-medicine, pre-dentistry
03. business
04. engineering
05. agriculture
06. accounting
07. fine arts (for example, music, painting, ballet, drama)
08. mathematics
09. history
10. biological sciences (for example, zoology, botany, physiology)
11. psychology

12. social sciences (for example, sociology, anthropology, political science, economics)
13. pre-law
14. liberal arts (for example, languages, philosophy, literature, history)
15. public administration
16. education (for example, grade and high school teaching)
17. coaching (or physical education)
18. other (specify on answer sheet)

46 - 48. What reasons will be important in deciding what college you will attend? (Blacken the circle for the most important reason.)
00. I do not plan to go.
01. athletic program
02. cost
03. family preference
04. size of college
05. nearness to home
06. strong student employment program
07. whether coeducational or not
08. location in relation to other school, big cities, climate, etc.
09. academic reputation of the college
10. excellence of training in field I am interested in
11. religious reasons or affiliation
12. studdnts have a pleasant social life there
13. the school will give me a scholarship
14. I can meet the admission requirements
15. the school's graduates can make good contacts
16. my high school faculty recommend it
17. my friends will go there
18. other (specify on answer sheet)

If you plan to go to college, how do you think your college education will be paid for? (If you have no plans and cannot say, you may skip the next five questions.)

49. About what per cent do you expect your family or relatives to pay?

50. About what per cent do you expect your summer earnings and part-time jobs to pay?

51. About what percent do you expect will be paid by a scholarship you hope to get?

52. About what per cent do you expect the government to pay (for example through ROTC, or by your attending West Point, Annapolis, etc.)?

53. About what per cent will you need to borrow?

Your Vocational Plans

This question is related to your past and present career goals. Please write your answers on the paper attached to your answer sheet. We would like you to try to recall what you wanted to become at different times in your life, and tell how you remember. For instance, "At 8th grade I wanted to be a musician. I remember this because at that time I was just beginning trombone lessons and I liked my junior high band leader very much."

Start back as early as you can recall and then describe the various major career goals you may have had up to and including your present ambitions. In describing your present vocational plans, please say a little about what you would expect to do in your work. Don't just list a job title, like "salesman", but try to describe what you think you might like to do as a salesman.

If your present career goal was influenced by someone in particular, please describe their relationship to you and their job, if they have one.

Student Reactions to Program
August 27, 1959

Name______________________________

You have been asked to answer certain types of questions at the beginning and at the end of this ten-week summer program. Our purpose has been to see if it is possible to measure certain changes which may have taken place during this period. In the following four questions, we would like you to try to estimate the relative importance of certain aspects of this ten-week experience. This is a very difficult task, but we though it might be easier for you if you think in terms of the tests which we have just given you.

1. Assuming we detect an improvement in your performance on the STEP Science test, what do you feel has contributed to this improvement? (Rank the possibilities in order of contribution: 1, 2, 3, etc. Rank only those items which you feel may be related to any possible improvement.)

____A. The first two weeks of classes here at Thayer.

____B. The nine Wednesday evening meetings.

____C. The help you received directly from the scientists and engineers with whom you worked these past eight weeks.

____D. The actual laboratory work itself, and the necessary reading done in connection with it.

____E. Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.

____F. (other possibilities)______________________________
____

2. Assuming we detect an improvement in your performance on the STEP Mathematics test, what do you feel has contributed to this improvement?

____A. The first two weeks of classes here at Thayer.

____B. The nine Wednesday evening meetings.

____C. The help you received directly from the scientists and engineers with whom you worked these past eight weeks.

____D. The actual laboratory work itself, and the necessary reading done in connection with it.

____E. Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.

____F. (other possibilities)______________________________
____

3. Assuming we detect changes in your responses to the Facts About Science test, what do you feel has contributed to this change?

____A. The first two weeks of classes here at Thayer.

____B. The nine Wednesday evening meetings.

____C. The help you received directly from the scientists and engineers with whom you worked these past eight weeks.

____D. The actual laboratory work itself, and the necessary reading done in connection with it.

____E. Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.

____F. (other possibilities)____________________________________

____

4. What aspects of this program helped in clarifying or perhaps even changed your career goals and your plans for realizing that goal?

____A. The first two weeks of classes here at Thayer.

____B. The nine Wednesday evening meetings.

____C. The help you received directly from the scientists and engineers with whom you worked these past eight weeks.

____D. The actual laboratory work itself, and the necessary reading done in connection with it.

____E. Extra science reading, stimulated by the program in general, but not necessary to your laboratory project.

____F. (other possibilities) ____________________________________

____

* * * *

The following three questions refer to the eight week laboratory experience which you have just completed.

1. Name of the person who gave you the most assistance:

____

(Dr., Mr., Mrs., Miss) (Name) (job title; e.g. physicist, electrical engineer, lab-technician, etc)

2. Do you consider the work you did this summer to be most like that of a research scientist, engineer, lab-technician, or some other classification? Explain.

3. What indications, if any, do you have that there may be a chance for you to continue work begun on this summer's project? Explain.

August 27, 1959

Name____

Your Present Career Plans

Please describe on this page your present vocational plans. Even though it is difficult to predict how you will be earning your living after you finish your formal education, at least try to describe what you would like to be doing and what you think your chances are of actually realizing that goal. Please be as explicit as possible. Also, please describe briefly your present educational plans for achieving this goal. What college do you expect to attend? (If several are still being considered, please list them in order of preference.) When was this decided if it has been decided? What field do you expect to concentrate in? Do you plan to go on to graduate school? In what field?

Rating Directions for Supervisors
Fall, 1959

As you well know, one of the more difficult tasks involved in planning a program like your summer science program is deciding how to select the participants from the hundreds of applicants. We would like to try to develop an improved procedure for selecting students for programs like the Thayer program, but in order to do this, we need your help.

We would like to get some idea of the sort of student you want in the program. To get this information, we would like you to rate those students whom you were able to get to know and observe last summer. Since the eight week laboratory session is the heart of the Thayer program, use the student's behavior and accomplishments in the laboratory situation as your primary consideration for rating.

The rating can be done by use of the attached class list. Place a check mark in the appropriate column(s) next to the student's name to indicate whether that student was in your class, your lab group, or just a casual contact. Then cross out those students that you didn't get to know at all and rate the rest in the column provided. Rate each student along a ten interval scale (0 through 9), a score of nine being assigned to the most ideal type student for the program, and a score of zero to the least desirable student for the program. Try to approximate a normal distribution along this scale by using the percentages below as a guide. It will be difficult to distinguish among the middle ("average") students, but do the best you can. In the space to the right of the column for rating, please describe the primary characteristic of that student which tended to influence your decision. No need to do this for all of the students, but at least the top 2 or 3 and the lowest 2 or 3.

After combining the results of the four raters, we will use multiple regression techniques to see to what extent the relative desirability of the students could have been predicted from the information available from your initial testing program and from our own personality, interest, and ability test scores.

* * * * * * * * * * * * *

Rating Score

Ideal Student for Program	9	8	7	6	5	4	3	2	1	0	Student not Suitable for Program
	2%	4%	9%	15%	20%	20%	15%	9%	4%	2%	

1959 Thayer Summer Science Program
Student Follow-up Questionnaire
Spring 1960

1. Name ______________________________ 2. Tel. No. ______________

3. Home address ____
Street City

4. Name of school ____

5. School address ____
Street City

6. Principal's full name:

7. Present science teacher's name:

8. Number of years you have had this same teacher:

9. Present math teacher's name:

10. Number of years you have had this same teacher:

11. Which teacher (in #7 or #9) is most familiar with your work and interests?

12. How many class periods are there in your high school each day? ______________
What is the average length of time of each of these periods? ______________

13. What courses did you take this year?

Course	For 1 or 2 semesters?	Number of periods/week	avg. grade

14. In your science class, how many class periods each week are usually devoted to laboratory work? ______________

15. Is this laboratory work usually done by yourself, or in groups of 2, 3, or more? ______________

16. What extra-curricular activities have you participated in this year? (List school clubs, athletics, church groups, music groups, etc. List offices which you hold with an asterisk(*).)

17. Have you discussed your last summer's experience with teachers, counselors, or administrators at your school? If so, with whom?

18. Have attempts been made to have you share your experience with other students? In what ways?

19. Has there been local publicity about your summer's experience, or have you participated in any community activity as a result of your experience? Describe.

20. List any local, county, state or national contests in which you have participated this year. List any awards which were received. (For example: Westinghouse, science fairs, Science Achievement Awards Program, etc.)

21. What contact(s) have you had with the following people since last summer? Briefly describe.

Thayer staff:

Summer Institute Students:

Laboratory staff:

22. To what college(s) did you apply? List in order of your preference.

Colleges	College action, if known (accept, reject, alternate)	Check final choice

23. When and how did you first hear of last summer's program?

24. List the names of students whom you know to be applying to next summer's institute at Thayer.

25. What are your plans for this coming summer?

26. Have you worked part-time during this school year? If so, please describe briefly.

27. What are the most important factors Thayer Academy should consider in screening applicants for their program?

28. What special science apparatus or other technical devices not available at your high school are you competent to use as a result of last summer's experience?

(use other side if necessary)

HARVARD UNIVERSITY

GRADUATE SCHOOL OF EDUCATION

Batchelder House, 7 Kirkland St.
Cambridge 38, Massachusetts

(Letter to principals arranging for
student interviews)

Dear

Last summer of your students participated in the Thayer Academy Summer Science Program for talented high school students. Because of the national interest in the future development of similar summer institutes, we have undertaken a follow-up evaluation of this program for the U.S. Office of Education.

The purpose of this letter is to seek your assistance. In order to determine the possible effects which this program has had on these students, we would like to make arrangements to interview each participant and his science or mathematics teacher some time this April. We hope that it will be possible for us to come to your school at a time when both student and teacher can be seen separately for consecutive periods of twenty to twenty-five minutes. In order to facilitate our visiting nearly forty schools, we would like to get some indication as to what times would be most convenient for this purpose.

On the enclosed form we have listed the names of those people we would like to interview. We would appreciate it if you would list blocks of time during the week which are suitable for this purpose. We shall confirm by telephone the exact time for the interviews after we receive your reply.

If you have any questions or uncertainties about this project, call and we will be happy to discuss them with you. Our phone number is UNiversity 8-7600, extension 2544. Your prompt reply to this request will be greatly appreciated. Thank you.

Sincerely,

William W. Cooley
Instructor and Research Associate

WC:ep
Enc: 2

1959 Thayer Summer Science Program
Student Follow-up Interview
Spring 1960

Student______________________________

ID__________

1. What science and mathematics activities have you engaged in since last summer? Which of these activities are a result of your experience at Thayer?

2. What has been the effect of the summer's program on your present study of science and mathematics?

3. What limiting factors prevent your spending more time with science or math at the present time?

4. What was your single most important accomplishment of last summer? (Others?)

   A. How was your research topic selected?

   B. Which students (3 or 4) in your section had the more outstanding research projects?

5. How did the program not fulfill your expectations?

6. To what extent might you have paid for your tuition and expenses in order to make it possible for more students to attend Thayer?

6B. Would you have preferred a boarding school summer program rather than having to commute? (advantages and disadvantes?)

7. If you were to spend this next summer engaged in some science or math activity, what would you most enjoy doing?

8. Plans for summer 1960? (Reasons for any difference from #7.)

9. College plans for fall 1960?

   A. Reasons for any change from prior plans?

   B. Influential adults or peers affecting change?

10. Expected college major?

    A. Reasons for any change from prior plans?

    B. Influential adults or peers affecting change?

11. Long range career plans?

    A. Reasons for any changes from prior plans?

    B. Influential adults or peers affecting change?

12. How has last summer's program affected your college and career plans? (in addition to factors listed in #9, #10, and #11)

1959 Thayer Summer Science Program
Teacher Follow-up Interview
Spring 1960

Student________________________

ID______________

Teacher________________________

Subject____________________

1. **What is he (she) doing in science (mathematics) this year? How is he doing?**

2. **Evidence of the effects of last summer's program?**

3. **What special provisions have been made for this student?**

4. **In what ways do you think such a summer program may contribute significantly to a student's total science education?**

5. **Did your school make definite efforts to encourage certain students to participate in the Thayer program? How did you decide whom to encourage?**

6. **Has this student discussed his college and career goal plans with you? What are your expectations?**

xxx

1959 Thayer Summer Science Program
Follow-up Questionnaire II
June 1960

______________________ (name

______________________ (date)

1. List the college(s) to which you were finally accepted. Circle the college which you plan to attend this fall. If you will not be going to college, please describe your plans for next year.

2. What have been the final plans which you have made for the summer? Where applicable, indicate the total gross salary which you expect to earn.

3. List any additional awards, recognitions, or achievements which you have earned about which we have not previously learned.

4. A regional science consultant or advisor might have provided information related to the following topics during this past school year. Place a check in front of those topics which you would have personally sought information:

___ career information
___ selection of colleges
___ selection of college courses
___ scholarships and financial help
___ available science and math contests
___ part-time school jobs in science and math
___ summer jobs in science and math
___ sources of special equipment and supplies
___ sources of special reference sources and textbooks
___ listing of current speakers and events of science and math interest in the Boston area
___ suggestion for science club activities
___ suggestion for science fair projects
___ (list any additional kinds of information which you would have liked to have had)
___
___
___
___

Do you consider that your school is generally capable of adequately supplying this type of information at the present time?

___ yes ___ no

HARVARD UNIVERSITY

GRADUATE SCHOOL OF EDUCATION

Batchelder House
7 Kirkland Street
Cambridge 38, Mass.

(Letter accompanying parent questionnaire)

Last summer your son or daughter participated in the Thayer Academy Summer Science Program for talented high school students. Because of the national interest in the future development of similar institutes, we have undertaken a follow-up evaluation of this program for the United States Office of Education.

The fact that your child participated in this program is evidence of your interest in such activities. Therefore, we hope that you might be willing to give us a few impressions of the program. The reactions of both the students and their teachers have already been obtained, but we feel that your opinions would be highly significant and possibly quite different.

This questionnaire may be filled out by either parent although we expect that in many cases both parents will enjoy discussing these questions together. Perhaps you have made additional observations which you believe will be helpful in our evaluation, in which case you are encouraged to use the back of this questionnaire.

If you have any questions about this project, call and we will be happy to discuss them with you. Our phone number is UNiversity 8-7600, extension 2544. Your prompt reply to this request will be greatly appreciated. Thank you.

Sincerely,

William W. Cooley
Instructor and Research Associate

WWC:an
Enclosure

Thayer Summer Science Program

Parent Questionnaire
May 1960

Student's Name:________________________

Parent (s) name filling out questionnaire________________________

Date:_______________

1. What do you consider to be the most important benefits of such a summer's experience for high school students?

2. Are there evidences of change in your son's or daughter's interests or activities (including career plans) which may be attributed to last summer's program? If so, describe.

3. Please describe those provisions or personal sacrifices which were required in your family in order to make it possible for your child to participate in this program.

4. List recommendations which you feel would provide for improved or additional summer opportunities for students of this age with similar interests and abilities.